DEDICATED

TO

THE MEMORY OF

J. H. CLARKE, DEAN

AND

FOUNDER OF

THE CINCINNATI COLLEGE OF EMBALMING

PREFACE

In writing this book the authors have taken cognizance of the necessity for a good working knowledge of Hygiene and Sanitation among embalmers. The position of the embalmer as a sanitarian is such as to provide him with great opportunities for the use of sanitation. These opportunities are just as great, if not greater, than those coming to the man in the medical profession, in the fact that no one is closer to the contagion and infection in and around the dead body, than is the practical embalmer, and those who are attending the funeral of the deceased. Later discoveries in the transmission of disease warrant saying that *actual contact infection* is becoming more and more recognized as a most active mode of dissemination. As against actual contact infection from a dead body, the embalmer, by a working knowledge of the nature, causation, modes of dissemination, and prophylaxis against disease, is in a position to actively combat the spread of disease in a decisive manner. In waterborne infections, the embalmer should assert himself in the absence of a regularly constituted health officer, and see that all fecal matter and other such discharges are rendered innocuous to the living. The knowledge of the subjects listed in Parts One, Two and Three of this book will place in the embalmer's hands effective and recog-

nized sanitary measures which he is to use when acting as a sanitarian, when such an officer does not exist, or to aid such a health officer in carrying out those sanitary principles in a community in which we are all so vitally interested. The inability of any organization to control the spread of disease throughout the rural districts in the same effective manner as could be done in larger organized communities is widely recognized. Air-borne infection, characterizing the dissemination of contagious diseases, is under a less decisive control than other classes. It is not so much the spread of a disease all over a rural district that we have reference to, as much as the spread of the disease to occupants of the same building in thickly populated tenement districts of our larger cities. It is entirely within the province of the embalmer to act as a fumigator or active sanitarian, and that, too, without encroaching upon the rights of any other recognized legal health officer, for general health and hygiene is everyone's business. This is not true of the embalmer who knows but little of the teachings and principles of sanitation, but is true of the person who has studied the principles as set forth in the teachings of this book or any recognized book, or who has been a student in a theoretical and practical manner under the supervision of qualified instructors.

Prophylaxis in general, covers the methods in use to check the spread of the disease, as well as the protection to those who are compelled, in the interests of their professional calling to be in close proximity to the body, as would be necessary where a body is to be embalmed. The authors remember at least a dozen instances where

careless and uninterested work in sanitation has resulted in the death of the embalmer, and one case in particular where twenty-two people died in an epidemic the result of careless work in sanitation on the part of the acting embalmer. Embalmers, through improvement in their sanitary knowledge, are allowed to preserve and disinfect bodies, and in that way allow of their transportation and return home to the last resting-place. The various state laws governing embalming make it necessary that disinfection of the body be complete, under the penalty of a revoking of license for careless work. It behooves the student to be more careful and painstaking in his work at all times.

It is for all of these reasons that we have spent many years in formulating the matter contained in this book. We have called on many authorities for information, among whom are Rosenau, Abbott, Renouard, Clarke, Meyers, Barnes, and those authors who have from time to time contributed articles to the current embalmers' journals. We are deeply indebted to these men for information which we hope will prove as beneficial to those who study from this text-book as it has been to ourselves.

Thoroughness has been our watchword in the preparation of these pages for the student's education, and thoroughness should be the watchword of the student in absorbing the theory and obtaining the practice in sanitation, so that our fullest duty to the dead body and to those left behind may be realized, and our position in the rank of professions elevated to the highest pinnacle.

THE AUTHORS.

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INTRODUCTION

Although everyone will admit the importance of hygiene and sanitary science, yet it seems often to be neglected. "Vigorous health and its accompanying high spirits are larger elements of happiness than any other thing whatsoever," and one way in which we can secure this happiness is by living up to the rules as set forth in the teachings of sanitary science and hygiene. It has been said that "health is a man's birthright; that it is as natural to be well as to be born," and it is from ignorance and transgressions of the sanitary laws that arise all disease and tendency to disease. In view of the great importance of hygiene and sanitation, let us as undertakers and embalmers do all that is in our power to help in the prevention of disease.

The Relation of the Undertaker to the Public Health.—The physician must do all he can for his patient—saving his life, and, if possible, restoring him to health. In addition to this, to protect others, if possible, from the disease. The undertaker's obligation to the dead ceases with the respect and consideration due their bodies, and in the restoration and maintenance of as nearly a natural appearance as possible. To the public his obligation is great in preventing, if possible, infection of the living, directly or indirectly from the dead.

The doctor's duty is to the living individual and to the public, and with death his responsibility ceases. The undertaker's duty is to the dead and the public, and with the death his responsibility begins. The respect and consideration due the dead is a matter of sentiment and ethics and is entirely subordinate to the welfare and the interests of the living. The management and disposition of the dead is not a business, but a profession, and that, too, of scientific principles and practical art. Adequate qualifications are necessary. The regulation of the undertaker's profession by law is due the dead, the undertakers themselves, and the living. It seems important that the undertaker should have a knowledge of the following:

(1) That the dead may communicate disease to himself and to others.

(2) That most of the acute diseases are infectious, depending upon living organisms, vegetable or animal, parasitic or saprophytic.

(3) The way and manner in which these organisms enter the living body.

(4) Their distribution in the body, whether local or general and whether the solids or fluids, or both, are infected.

(5) The way and manner of their elimination from the the body.

(6) The way and manner in which they are transferred to others.

(7) That with the death of the host the bacteria do not concurrently die.

(8) The way and manner in which bacteria may be eliminated from the dead.

(9) The modes by which such eliminated bacteria may be transferred to the living.

These should be a part of the scientific instruction of the undertaker.

The Purposes of an Undertaker.—(1) To prevent and destroy putrefaction and restore the body to as nearly a natural appearance as possible. (2) To destroy all pathogenic bacteria, to prevent communication to the living, and contamination of the soil from the grave.

In the body, dead of an infectious disease, there are present living pathogenic bacteria whose activities have ceased and living saprophytic organisms whose activities begin. If the body is let alone, under favorable conditions, temperature, moisture, etc., the saprophytes will continue until the putrefactive portions of the body, soft parts and fluids, have been reduced to their normal elements, not dust, and in this general decomposing process the living pathogenic bacteria are destroyed.

Decomposition, therefore, is nature's way of destroying pathogenic bacteria and decomposing the body compounds to their normal elements. Both of these are conservative processes. During the process, however, there is danger of dissemination of pathogenic bacteria and possibly the generation of saprogenic poisons which may be dangerous if they find their way into the living body. From the sanitary standpoint, the destruction of the pathogenic bacteria is by far of the greatest importance.

The method by which this may be accomplished is disinfection. (See Chapter X). Infected sputum, urine, feces, discharges, etc., from the living are best dealt with by burning. The same is true of all infected materials,

cloths, bedding, etc. This form of disinfection is not always practical, as the destruction of property is expensive. Other forms of disinfection, though, can be used to great advantage. As to the cremation of dead human bodies, as a means of disinfection, public sentiment does not approve at this time, therefore a regulation to that effect would be ignored, although it is thought by some that the evolution of sentiment will lead to the adoption of cremation for the disposal of the dead. Disinfection consists in the employment of some chemical which will enter the protoplasm of the bacteria and destroy or poison them. Fortunately this applies to both pathogenic bacteria and the saprophytes of putrefaction. The process by which this is accomplished is called *embalming*. This is applicable to the dead only. The great problem in curative medicine has been to find a chemical that will seek out the pathogenic bacteria in the living body and destroy them, and not hurt the living normal cells. The undertaker, of course, does not consider the cells of the body, so far as their protoplasm, function or life is concerned. Relation, symmetry, color, etc., from the viewpoint of appearance is all that concerns him, so far as the body itself is concerned. The antiseptics used in embalming, which in quantity and strength would be fatal to living cells, is to dead cells preservative by destroying putrefactive saprophytes that would destroy the cells and tissues of the body. To successfully embalm a body, the embalming fluid must come in contact with the tissues and fluids of the body to prevent putrefaction, and with all tissues and fluids that may contain pathogenic bacteria. If this is accomplished, then the objects

of embalming are attained, viz.: the prevention of putrefaction and the death of pathogenic bacteria. It produces a sterile body, safe from decomposition and safe so far as communication of disease is concerned. Anything short of that implies a corresponding percentage of failure. It must be remembered that embalming may be sufficient to preserve the body for a time and to prevent immediate communication of disease, but may not suffice to prevent contamination of the soil. With the proper treatment, embalming may be said to prevent contamination.

PART I.

THE PREDISPOSING CAUSES TO DISEASE.

Hygiene and Sanitary Science

CHAPTER I.

THE PREDISPOSING CAUSES TO DISEASE.

Hygiene is a science that deals with the laws of health in the broadest sense. *Personal hygiene* is that branch of the science which deals with man himself and how he is to keep healthy.

Practical hygiene or sanitary science is the art of preserving health, or, of preventing disease, and includes a consideration of the methods that are employed in investigating the manifold phases of the subject.

Sanitary bacteriology deals more particularly with the channels by which bacteria leave the body and pass into the outer world; with the mode and duration of life, of disease germs, in water, food, soil and air, and with the avenues by which these disease germs are able again to approach and infect the healthy individual.

For the undertaker and embalmer, we do not care so much about personal hygiene, or man himself, as we do about practical hygiene or man's surroundings. We want to determine in how far these conditions which the embalmer meets daily are conducive or detrimental to man's well-being, and to bring about the greatest amount

of disinfection possible, not only in the house in which man died, but by thorough and sanitary embalming, the complete disinfection of the body itself after death. By a complete knowledge and a strict adherence to these laws the undertaker and embalmer will, when acting as a sanitarian, maintain a healthy and sanitary condition in the house and community in which death has occurred from a contagious or highly infectious disease.

Sanitary science is no new thing. From the earliest to the present time we have had ecclesiastical and medical writings for the sanitary guidance of man. It is largely due to the inculcation of these precepts, handed down from generation to generation, that we follow certain customs to-day and instinctively avoid certain conditions then thought to be harmful.

The laws of Moses, although religious laws, were practically sanitary laws for the guidance of his people. As long as they obeyed these laws they were a healthy people, but when broken, disease reaked in their camp and sometimes whole tribes died.

The public bath-house instituted in the Alexandrian period shows that the earlier civilizations held the question of public health as of vital importance.

The Egyptians embalmed their dead. Perhaps this was a religious custom, but we do know that it was a sanitary measure, for the processes which they employed were sufficiently perfect to secure them an indefinite preservation.

With the progress of time the earlier sanitary codes had to be recast to meet the requirements of newer conditions. The older regulations were based upon speculation

and erroneous conceptions, but it must be admitted that they erred more frequently on the right side than on the wrong.

The foundation of modern hygiene is laid in the scientific investigations of Von Pettenkofer, Voit, Koch and others. With the impulse given to the work by the intelligent deductions of these pioneers, there was a development, and to-day the field of hygiene and sanitary science has assumed such vast proportions that it has been divided up into specialties.

The undertaker or the embalmer often must act as the sanitarian in small communities where they do not have a health officer. He must have the special knowledge necessary to thoroughly embalm the body, and to perform complete disinfection, or at least be able to advise the people of the community how it should be done.

Why should the embalmer, trained to properly embalm, equip himself with a knowledge that he is to employ in preventing death? Why should the embalmer practice disinfection and sanitary science to keep the people from dying? These are questions that are sometimes asked. One might as readily ask, "Why does one experience the impulse to rescue a stranger from danger in whom he has no direct interest?"

There is a moral reason why the embalmer should use his best endeavors to lessen suffering and save life, in so far as it lies in his power to do so, and this, too, regardless of whether it is to be of direct profit to him or not. Secondly, there are material reasons for the embalmer to have a fairly accurate knowledge of the advances in preventive measures of sanitary science. His patrons

demand it. With the universal progress in general education, the public is no longer satisfied that an embalmer enter the house, do his work in a haphazard way, and depart. They demand more. They wish to know the most likely channel or channels through which the disease may be contracted, and the most reliable means of preventing its recurrence or spread, if the body can be embalmed to make the public safe at the time of the funeral. If the embalmer can not supply reasonable answers to these questions, he need not be surprised if his employment is given to someone else who can. Thirdly, for his own enlightenment and personal welfare the embalmer should be familiar with the sanitary laws, especially those concerning the causation and spread of diseases and the means of prevention. He should be familiar with the channels through which he himself may become infected, or the means by which he may serve as the carrier of disease germs, and the proper precautions for preventing such infection. As an educated embalmer he should know, and as a conscientious embalmer he should practice these precepts for the good not only of his own patrons, but of the community of which he forms a part.

From time to time the teachings of hygiene are assailed by hostile attacks, and proof is demanded as to whether the practice of sanitary precepts has resulted in the betterment of the conditions under which mankind lives, in the prevention of disease, or in the saving of life. While it can not truthfully be said that every so-called sanitary precaution is beneficial or necessary, or that every article in the sanitary code is based on that which is proved to be sound, nevertheless we can combat ad-

verse criticism with an array of evidence that would convince the most skeptical as to the importance of an intelligent sanitary control of the conditions under which we live. For instance, to sight a few of the triumphs of hygiene, until the beginning of the present century the average percentage of deaths from smallpox in Prussia was 3 per 1,000 of population. Since the introduction of compulsory vaccination the mortality from this disease has fallen to its present figure of .03 per 1,000 of population.

Typhus fever, so frequent in former times among the inmates of overcrowded hospitals and other public institutions, has, under modern sanitary conditions, become a rarity. As a result of the proper drainage of the soil, a diminution in the frequency of pulmonary, intestinal and malarial troubles has everywhere been observed.

The triumphs in the art and science of sanitary embalming are no less marked. The old ice-box has been superseded by the injection of the arterial system with the embalming fluid. The educated embalmer is assured that he can absolutely kill all germ life existing in or about the body, can render the body innocuous to the living, by the use of disinfecting solutions, and, too, can get the desired cosmetic effects. Dropsical cases are being taken care of in a sanitary way. Contrast, if you please, the time when these cases distended with water and inflated with gases were hauled to the cemetery, a stream of dropsical water running out of the back of the hearse. We have the complete disinfection of the body, so that it can be transported from one part of the the state to another, or from one continent to another, with

perfect safety and preservation. Our loved ones are no longer buried at sea, for our ocean steamers are carrying embalmers who, trained in their profession, are able with the modern light of sanitary science and embalming to so preserve the body that it can be taken to shore and then home, where it may have a burial as the family so desires.

In citing these illustrations it is not our desire to leave the impression that our stock of knowledge is complete in all details, or that the knowledge we possess is utilized by every one to the extent that its importance demands.

As has been stated, the object of hygiene is to prevent disease. It is therefore imperative that we have an understanding of the means employed in securing this end, and that we possess a clear comprehension of the factors concerned in the causation and dissemination of disease.

The causative factors in disease are manifold; they differ in nature the one from the other, and are of varying degrees of importance in their relation to morbid conditions. Besides traumatisms and direct poisons, there is probably no single absolute cause of disease, but that the abnormal state we call disease represents a chain of circumstances, the various links of which, while having more or less direct bearing upon others, are of different degrees of importance to the progress. Thus we say that tuberculosis is caused by a specific organism, and no one doubts this but at the same time there is no one who believes for an instant that if to a number of individuals in sound health this microorganism gains access, tuberculosis will certainly result in all cases.

There are other factors that come into play and must be taken into consideration. On the one hand there are circumstances that modify disease-producing powers of the microorganism, so that at one time it may be comparatively feeble as regards this property, while at another it is infective to the fullest extent.

On the other hand, there are modifying influences constantly at work upon individuals, some of them placing him in a condition to survive exposure to the most virulent forms of infection, while others so modify the normal vital resistance with which nature has provided him that he readily falls a prey to what would otherwise be a comparatively insignificant foe.

Certain influences to which man is exposed during the course of his existence predispose him to disease in general. Other influences are concerned in directly exciting certain definite groups of symptoms.

The Predisposing Causes of Disease.—By this term is meant those conditions with which man is surrounded that have a tendency to so reduce his normal vital powers so he is no longer capable of resisting the inroads of the direct exciting causes of disease. Agencies that tend to reduce the general health, such as exposure, fatigue, malnutrition, debauch, etc., tend likewise to diminish the vital resistance, and in this manner render the individual more susceptible to disease. "The ability of a microorganism to produce disease in individuals of a particular race or species may be modified by a number of general factors that predispose individuals to infection or endow them with resistance. The conditions that determine whether a microbe can bring about infection or not are very various."—Jordan.

Age.—The age of an individual is of great importance. Experiments have shown that while the adults of certain animal species are resistant to inoculation with particular germs, the young of the same species will succumb. The existence in the human race of a number of children's diseases, which are not only more common but more fatal among children than among adults, is evidence to the same effect.

Age can not be ignored. The greatest number of deaths, and hence the greatest amount of sickness, occurs among the very young and the very old, i.e., before the age of five and after the age of sixty-five to seventy years.

In infancy and childhood we have:

(1) Diseases connected with the development of anatomical structures and the establishment of physiological functions.

(2) Diseases dependent upon the congenital defects.

(3) Diseases due to special hereditary tendencies.

(4) Diseases consequent upon the neglect of careless and inexperienced mothers.

(5) Diseases resulting from undue exertion, as of occupation, during and after pregnancy.

(6) Diseases that occur in consequence of improper food and clothing, lack of cleanliness and pure air.

(7) Diseases of a contagious character, occurring, such as measles, mumps, etc.

In old age we have:

(1) Diseases that depend upon the gradual loss of power on the part of the organs to perform their normal physiological functions, with the consequent disturbances

of nutrition and the multiform abnormal manifestations that this defect entails.

(2) Diseases degenerative in nature and which simply indicate irregularities that are incidental to the progressive wearing out of the machinery of life.

(3) Diseases of the heart and arteries, renal and hepatic systems, catarrhal conditions of the mucous membranes, intemperance, rheumatic conditions, gouty affections, cancers, tumors, etc.

In adult life any disease may occur. During this period man's freedom from or affliction with diease will depend very largely upon the conditions under which he lives.

The undertaker and the embalmer is able then to determine by the age of the subject the class of disease to expect. For example, he would not find a hardened condition of the arteries in a child, but would be very liable to get this condition in the adult over the age of thirty. He would not as a rule find contagious diseases such as measles or scarlet fever, etc., in adult life, but would be very liable to find these diseases in the child.

The age of the subject will also determine the amount and character of the fluid to be used. In the child the undertaker will use less fluid and of less astringent character, whereas in the adult more fluid will be used and the astringency will be greater.

Sex.—The sex of an individual is a predisposing factor because of the particular anatomical structure.

Males afford a greater number of deaths than females from the following:

Typhoid,
Venereal diseases,
Alcoholism,
Lead and other forms of poisoning,
Tetanus,
Convulsions,
Diseases of the brain and cord,
Diseases of the liver,
Renal diseases,
Bladder and genito-urinary diseases,
Bone diseases,
Accidents.

Females succumb more frequently than males to
Malaria,
Cancer,
Anemia,
Diseases of the stomach,
Diseases of the reproductive organs,
Peritonitis,
Diseases incidental to pregnancy and child-birth.

The undertaker and embalmer would not ordinarily expect to find a case dead of alcoholism in the female, but he might expect to find such a case in the male. We all know that a case of alcoholism is hard to treat, so our fluid would have to be modified to meet this condition. He would not find a case of puerperal septicemia in the male, but might expect such a case in the female at any time. Here again the fluid would have to be modified to meet the condition in hand.

Race.—Some races exhibit a peculiar susceptibility to certain maladies, while others possess a comparative

degree of immunity from them. The negro is less susceptible to yellow fever and malaria than the white man. The white man is less susceptible to pulmonary troubles and cholera than the black man. The German is more susceptible to cancer than the Celt. The Jew escapes more frequently from disease of a tuberculous nature and from epidemic diseases than does any other race of mankind. An explanation of this vital advantage on the side of the Jews is stated by Richardson as follows: "The causes are simply summed up in the term 'soberness of life.' The Jew drinks less than the Christian, he takes as a rule better food, he marries earlier, he rears the children he has brought into the world with greater personal care, he tends to the aged more thoughtfully, he takes better care of his poor, he takes better care of himself."

It is probable that there is no disease to which mankind is liable, from which any race of mankind possesses absolute natural immunity.

Occupation.—Certain kinds of occupations predispose to disease. However, with most occupations, disease is not due to the character of the work done, for moderate work of almost any kind, when done under favorable conditions, must be considered as in every way advantageous to the physical, moral and mental wellbeing of the worker.

The conditions of occupation that most frequently predispose to disease and ill-health are generally poor hygienic surroundings, such as overcrowding in poorly ventilated, improperly heated, damp, and uncleanly offices and workshops; the inhalation of dust-laden atmosphere; exposure to extremes of weather, as heat, cold, and excessive moisture; the evil effects of working

in cramped or strained attitudes, particularly such as interfere with the normal action of the heart and lungs.

Density of Population.—Sickness and death are most frequent in those communities where large numbers of people are crowded together in comparative close quarters under the conditions of poverty.

Heredity.—By heredity we mean the influence of parents upon offspring. Heredity is the peculiar tendency existing in some families to nervous diseases, to epilepsy and insanity; in other families the peculiar tendency to scrofulous, tubercular, rheumatic and gouty affections. Some families have a marked predisposition to acute diseases, while in others there is a marked resistance to them.

The inheritance of a tendency to or an immunity from disease is due fundamentally to the same process through which peculiarities of the physical, moral or mental nature are transmitted.

The question concerning the direct transmission of disease from parents to offspring is often disputed, but there can be no dispute about the hereditary tendency to a disease. Children born of parents having weak lungs and a general enfeebled constitution, will have a predisposition to pulmonary affections.

Season.—Certain groups of diseases are most prevalent at certain seasons of the year. During the months of low temperature we have catarrhal diseases and diseases of the respiratory system. Typhoid fever is a disease of the early autumn, the greatest death rate occurring during the months of August, September and October.

Hunger and Thirst.—Hunger and thirst predispose to infection. If pigeons are kept on a low diet before or just after inoculation with anthrax bacilli, they die, although under normal conditions these birds are naturally immune to anthrax. Animals deprived of water also lose their natural resistance to anthrax inoculation.

An unsuitable diet, as the substitute of bread and milk for meat, has the same effect.

Heat and Cold.—Exposure to extremes of heat and cold is well known to depress resistance to infection. This is shown by one of Pasteur's classic experiments, in which he rendered the naturally resistant hen susceptible to anthrax by chilling it with cold water.

The prevalence of pneumonia in man in those months of the year when the influence of cold upon the human being is most felt, affords another illustration of the same fact.

Frogs, which are immune to anthrax at ordinary room temperature, quickly die after anthrax inoculation if placed at a temperature of 25 to 35 degrees Centigrade.

Hot and moist climates are seats of disease. Dry climates, either cold or hot, are comparatively healthy.

CHAPTER II.

THE EXCITING CAUSES.

The Exciting Causes of Disease.—The term direct or exciting, as applied to the cause of disease, is limited to those chemical, physical and mechanical agencies that are capable of inducing abnormal conditions in the organism without the intervention of any other modifying factors.

The vital agents too, we believe, are capable at any time of performing their characteristic pathologic function, provided the body is in a peculiarly receptive condition. This receptive condition usually depends upon some influence already mentioned as predisposing.

The exciting causes of disease after birth must, of necessity, be of external origin. It is evident that these causes of acquired disease are either of the nature of alterations in the environment which tell directly upon one or another tissue, or are due to the entrance into the system from without of substances, either living or dead, which have a deleterious action upon the functions of the tissues.'' Thus briefly we may classify the agents producing disease acquired after birth into: (1) *Chemical.* (2) *Physical.* (3) *Mechanical.* (4) *Vital.*

Chemical.—The direct chemical causes of disease are divided into those having their origin outside of the body and those that are created inside the body.

Ectogenous.—Are those that have their origin outside the body. They comprise the numerous organic and inorganic substances of irritating or poisonous nature, that possess the property of causing abnormal local or constitutional diseases.

The most common of these are (1) the various hurtful substances used in certain trades, as for example: phosphorus, arsenic, mercury, acids, etc. (2) Those used as drugs, such as opium, chloral, cocaine, alcohol, etc. (3) The poisons of some plants, such as Rhus Toxicodendron, Atropa Belladonna, Hyoscyamus niger, Ricinus Crotin Tiglium, etc. (4) The poisons of venomous reptiles.

Endogenous.—Are those that have their origin inside the body. They are created as the result of mal-nutrition, mal-formation, and other defects of metabolism and physiological functions.

A poison is a non-organized substance, organic or inorganic, existing within the organism or introduced from without, which, from its chemical composition, is able under certain conditions to be harmful to human beings, by destroying or effecting their health or relative well-being.

Physical.—The most frequent direct physical causes of disease and death are excessive heat, cold and moisture. Physical agents, such as heat and cold, can either cause the suffocation or freezing of a person so as to excite disease or death.

Mechanical.—Under mechanical causes of disease we would have all those conditions in which structural or physiological diseases are brought about by mechanical

means, such as accidental causes, etc. Under this form no disease of germ origin would be classed, but simply those diseases which are brought about by accident, etc.

Statistics have been formulated giving the number of persons affected by accidental causes of disease. In the number of persons affected the list is as follows:

Every	year,	11,000,000
"	day,	30,137
"	hour,	1,255
"	minute,	19

Of the above numbers the following number die and are treated by the undertaker:

Every	year,	57,000
"	day,	156
"	hour,	7
"	9 minutes,	1

Out of each 100 deaths from all causes there are deaths from accident to the number of 6, making a percentage of 6.

The undertaker, then, should make a special study of the treatment of accidental causes of death in order that he may be able to cope with any situation. As a rule the only concern from a bacteriological standpoint is the gas bacteria which may infect the blood of the body, thereby giving rise to capillary and tissue gas.

CHAPTER III.

THE EXCITING CAUSES.—Continued

Vital Causes.—By the term vital causes of disease is meant those living germs which, having gained access to the body, produce as a result of their development under favorable conditions, tissue lesions that terminate in the disturbance of important vital functions and frequently in local or complete death of the host in which they are developing.

Germs are the lowest forms of vegetable or animal life, and include the terms microbe, bacterium, ovum, spore, an undeveloped embryo, etc.

A microbe is a microorganism, or an organism so small that the microscope must be used to make it visible.

A bacterium, a genus of fission-fungi, meaning the lowest form of plant life, deriving its substance from dead organic matter and dividing by direct division.

An ovum is the female reproductive cell of an animal or a vegetable.

A spore is any reproductive element less organized than a true cell. A spore is a highly resistant organism produced by a bacteria, yeast, or mould, that will again, when it comes under favorable conditions (as the seed will the plant), reproduce itself and produce like kind from which it came.

An undeveloped embryo is the first cell in human

life, which if fertilized and developed would result in a foetus.

A germ cell is a cell resulting from a fecundal germinal vesicle.

A germ disease is any disease of microbic origin.

Germ force is plastic or constructive force. It is that force which is stored up in the seed, and, when planted in the proper soil, with the required temperature and moisture, will cause it to grow.

Germ plasm is germinal protoplasm transmitting inherited peculiarities.

The germ theory, (1) the theory that all infectious diseases have a germ origin. (2) The doctrine that every living organism has its origin from a germ.

Germs are divided into vegetable parasites and animal parasites.

Animal Parasites.—The lowest group of the animal kingdom is known as the protozoa. The protozoa are distinguished from the higher animals by the fact that each organism consists of but a single cell. The disturbances that result from the invasion of the body by animal parasites or protozoa vary with the character, mode of nutrition, life cycle, and location of the invading organism. In the one case they may manifest themselves through symptoms that point more particularly to the circulating blood; in the other, by more or less grave disturbances of nutrition. Again, nervous irritability will be observed. In special instances marked and persistent diarrhea results, while in other instances the results of their presence in the body produce mechanical irritation.

A great many protozoa are pathogenic to man as well

as to animals. Dysentery is due to an animal parasite. Malarial fever is also due to animal parasites, which are carried into the body by the bite of certain kinds of mosquitoes.

Vegetable Parasites.—Vegetable parasites are divided into bacteria, yeasts and moulds.

Bacteriology.—The role which bacteria play in the production of disease is quite important. Bacteriology is the science which treats of bacteria and the lowest forms of microorganisms in vegetable and animal life.

Discovery of Bacteria.—The belief that there are living organisms too small to be seen by the unaided eye, and that such invisible organisms play an important part in the various natural phenomena, has found utterance many times since the dawn of history. Several of the philosophers of antiquity were bold enough to surmise that such organisms existed, and some writers even framed their speculations on this subject in phrases that seem like far-seeing anticipations of modern discoveries.

Interesting in some degree as these speculations are, they appear to have had no influence whatever upon the course of scientific investigation, and to have been let fall at random by their authors, like hundreds of similar conjectures, without any real basis in observation or experiment.

The fact is, that prior to the work of the Dutch microscopist, Anthony van Leeuwenhoek, in the latter part of the seventeenth century, definite ocular proof for such a belief did not exist. Leeuwenhoek (1632-1723), who was a skilled lense maker of Delft, Holland, spent many

years in examining through his microscope a great variety of natural objects, with unremitting industry if without system, and in the course of his observations chanced to come across the organisms now known as bacteria. In a letter to the Royal Society of London, dated Sept. 14, 1683, he records in these words his observations upon some tartar scraped from the teeth and mixed with water: "I saw with wonder that my material contained many tiny animals, which moved about in a most amusing

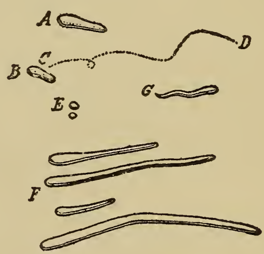

Fig. 1.—The first pictorial representation of bacteria. Leeuwenhoek, 1683 (Loeffler).

manner; the largest of these (a) showed the liveliest and most active motion, moving through the water or saliva as a fish of prey darts through the sea; they were found everywhere although not in large numbers. A second was similar to that marked (b). These sometimes spun around in a circle like a top, and sometimes described a path like that shown in figure (c-d). They were also present in large numbers. A third kind could not be distinguished so clearly; now they appear oblong, now quite round. They were so small that they did not seem larger than the bodies marked (e), and besides they moved so rapidly that they were continually running into

one another; they looked like a swarm of gnats or flies dancing together. I had the impression that I was looking at several thousand in a given part of water or saliva, mixed with a particle of material from the teeth not larger than a grain of sand, even only when one part of the material was added to nine parts of water or saliva. Further the greater part of the material consisted of an extraordinary number of rods, of widely different lengths, some curved, some straight, as (f). Since I had previously seen animalcules of this same kind in water, I endeavored to observe whether there was life in them, but in none did I see the smallest movement that might be taken as a sign of life.'' Leeuwenhoek supplemented his observations with drawings, and there is no doubt that he was the first to see bacteria and to describe them accurately.

Origin of Bacteriology.—Leeuwenhoek's observations remained practically isolated and without fruit for nearly a century. In 1786 the Danish zoologist, O. F. Muller, took up the work and succeeded in discovering many structural details of which his predecessors had been ignorant. Ehrenberg (1795-1876) succeeded in giving a somewhat complete classification. Then follow Dujardin, Perty, Cohn, and Nageli.

Pasteur (1822-1895) showed that bacteria and kindred microorganisms were responsible for setting in motion and carrying out many every day processes, the nature of which had not been understood, or which had been incorrectly assigned to the ''Oxygen of the Air,'' or to other inorganic agencies.

Putrefaction and decay were shown by Pasteur to

be not fields for "spontaneous generation" of life, but manifestations of chemical disintegration due to the metabolic activities of microorganisms engaged in satisfying their need for food.

Fermentation was shown to be caused by the effort of living and growing yeast cells to satisfy their nutritional requirements.

Pasteur is looked upon as the founder of the science of bacteriology. Robert Koch must be regarded as establishing bacteriology on the basis of an independent science.

The postulates of Koch are as follows:

(1) That the microorganisms under consideration shall always be found in the diseased tissue, and in such relation to these tissues that they can be reasonably assigned an etiological relation to the process.

(2) That the microorganism shall be isolated from the diseased tissue in pure cultures.

(3) That the pure cultures of the microorganisms shall be capable when inoculated into susceptible animals, of reproducing pathological lesions identical with those from which they were originally isolated.

(4) That the microorganism shall be found in the lesions produced by the inoculation.

Scope of Bacteriology.—Although from a practical point of view, the part played by bacteria in the causation of disease in man must be admitted to be of surpassing importance, it must not be forgotten that bacteria exert a marked influence upon the welfare of mankind in many other directions.

Bacteria not only disintegrate and destroy dead bodies

and attack and kill living organisms, but some forms are also constructive to a high degree, and translate important chemical elements, like nitrogen and carbon, from unavailable combinations into substances that can be utilized by higher forms of plant life.

It has been discovered, for example, that certain kinds of bacteria profoundly modify the composition of the soil and the character of the crops, and are hence of importance to the agriculturalist; that other kinds of bacteria impart the characteristic flavors and aromas to butter, cheese and other dairy products; and that still others determine the success or failure of various industrial processes, such as retting of flax, the tanning of hides and the curing of tobacco. It is believed by many that the applications of bacteriology to various industries and manufactures and to agriculture are likely to become much more numerous in the near future.

Bacteria in the Air.—As might be supposed, the number of bacteria in the air bears a close relation to the quantity of suspended dust particles. There are fewer bacteria in the air of the country than of the city; there are fewer in the mountain air than in the air of the lowlands; the air in mid-ocean and in high altitudes is generally germ free.

Pasteur, in an experiment made during the course of his celebrated researches on spontaneous generation, observed that only twelve of the flasks out of twenty of organic infusion, which were opened at a low altitude, escaped infection, while out of twenty opened on the Mer de Glace, nineteen escaped.

Tyndall's experiment at the Bel Alp, in Switzerland,

was a yet more emphatic instance of the same kind. Ninety per cent. of the flasks opened in a hay loft were smitten, while not one of those opened on the free mountain ledge was attacked.

The kinds of microorganisms in the air vary somewhat in different localities, but certain forms are pretty uniformly present. Moulds and yeasts are quite common in the atmosphere and in some situations outnumber the bacteria.

Bacteria in the Soil.—The distribution of the bacteria in the soil is naturally dependent upon the presence of organic matter, moisture and other factors that influence the development and continued vitality. More bacteria are found, for example, in manured soil than in dry sand. The upper six inches of the soil are the richest in bacteria. Few bacteria are found in the undisturbed soil below a depth of four or five feet.

The supply of bacteria in the soil is continually being renewed by the excrements of animals, by the bacteria concerned in the various fermentative and putrefactive processes occurring everywhere, and by those that are precipitated from the air by the rain.

Spores of the anthrax bacillus may retain their vitality and virulence in the earth for many years and pasture lands that are once infected with anthrax, become practically unsafe for grazing cattle. Typhoid bacilli sometimes find their way into the soil along with human excretia. For this reason, feces should always be disinfected.

The burial of bodies of persons dying from infectious diseases does not as has been sometimes surmised tend

to perpetuate pathogenic germs. Rather elaborate experiments by Losimer and others have shown that the longevity of non-spore bearing bacteria under the ordinary conditions of earth burial is not long, a few weeks sufficing for the complete disappearance of the cholera spirillum, and the bacillus diphtherae, etc.

The arguments against earth burial therefore, do not seem to be decisive; whatever the force of esthetic and economic objection may be, the soil seems to go through a process of self-purification.

Biologic Significance.—The fact should not be overlooked that bacteriology owes its present important place among the biologic sciences quite as much to its general scientific significance as to the success of its practical applications. It has been often pointed out that the change in man's conception of the world around him that has been produced by bacteriology is so sweeping as almost to deserve the term revolutionary. Up to the middle of the nineteenth century the character of many of the most familiar of natural processes, such as decay, fermentation, and the like was entirely misunderstood; contemporary spontaneous generation of at least the lower forms of life was the general accepted belief of most scientific men; infectious diseases were not sharply differentiated from one another and the most fantastic hypotheses were advanced to explain their existence.

Although the great mass of material phenomena elsewhere had been brought into apparent orderliness and system, yet here was a region in which the unscientific imagination rioted in mystery and extravagance. The penetration of this realm of obscurity by the discovery

of bacteria, gave the human race for the first time in history a rational theory of disease, dispelled the myths of spontaneous generation and set the processes of decay and kindred phenomena in their true relation to the great cycle of living and non-living matter. The new conception of the microscopic underworld which bacteriology brought into biologic science must be reckoned as a conspicuous landmark, and in so far as it has changed the attitude of man toward the universe, should be regarded as the most important triumph of natural science.

Bacteria.—For the human being and many of the lower animals, the most important of the vegetable parasites that are directly concerned in the production of disease are the bacteria. *Bacteria are the smallest and simplest forms of plant life known, consisting of a single cell and devoid of chlorophyll.* Or another definition would be that *bacteria are unicellular vegetable microorganisms that multiply by transverse division.*

Morphology.—Individual cells differ in size, shape, method of cell division, spore formation and the like. Masses of cells when grouped together are called colonies. The average bacterium of rod shape measures about two microns in length, and 0.5 microns in diameter. (One micron is equal in length to 1-25,000 of an inch). One large spherical bacterium that has been described measures about two microns in diameter.

Bacteria divide by transverse division. That is, if the bacteria are in the proper temperature, moisture, and media, in one hour we would have two, in two hours we would have four, in three hours we would have eight, in

four hours it would be sixteen, etc., etc., until in three day's time 4,720,000,000,000 would be produced. No organism, however, as was pointed out by Darwin long ago, can increase in exact geometric progression, for various checks and hindrances are always placed upon its multiplication by natural causes. In the case of bacteria, a potent factor that tends to prevent unlimited multiplication is found in the interference with growth caused by the substance produced by bacteria themselves. All other factors, such as insufficient food, lack of moisture, unsuitable temperature, and the competition of other kinds of bacteria, play a part.

A capsule sometimes surrounds bacteria, and in stained preparations is seen as a halo.

A cell membrane encloses the bacteria, which differs from the cell membranes of plants in that it contains no cellulose.

The bacterium has no true nucleus, but the nuclear material is generally conceded to be distributed about irregularly in the cell substance.

Flagella, are long, fragile, filamentous appendages, which originate from the outermost layer of the cell, and convey the power of locomotion to the bacteria.

Bacteria are greatly effected by temperature, light, moisture, oxygen supply, and food supply.

The Bacterial Requirements.—The requirements are the proper temperature, moisture, and media.

By the proper temperature we mean that each and every class of bacteria has an optimum temperature, at which growth takes place best. This can be modified to some extent by gradually increasing or diminishing

the temperature. Thus a bacterium that normally grows at 37 degrees Centigrade, or body temperature, can by proper methods, be made to grow at a much lower temperature. Each bacterium has a maximum temperature at which it will grow, and if taken above or below these temperatures will either produce the spore form or die.

The same can be said in regard to moisture. Moisture, although absolutely necessary, can be diminished, but if diminished too far, the bacteria will dry up and die, or else change into the spore form.

In regard to media, each bacterial colony grows best on the cultural media it has been used to growing on. If this media is taken away, the bacteria will die or else change into the spore form. And it may be said that just as a fish needs water for life, so do the bacteria need the proper temperature, moisture, and media, for life.

Spores.—A spore is a highly resistant body produced by a bacterium, yeast or mould, that will again when it comes under favorable conditions reproduce itself (as the seed does the plant) and bring forth like kind from which it came. Fig. 3 and 6.

The bacteria which produce spores are called *spore bearing bacteria.* The spore bearing variety are by far the most hearty and resistant to the effects of destructive disinfectant agents. The non-spore bearing variety, as a rule, possess very light powers of resistance to destructive agents, and are killed quickly.

True spores resist a temperature of from 70 to 100 degrees Centigrade, and are characterized by definite structural qualities. They are approximately spherical or oval in shape. Spores are highly resistant to all sorts

of injurious influences. When the spore begins to form, the nuclear material is concentrated into a hard mass. A spore may be formed in any part of a cell, sometimes in the center and sometimes at the end. As a rule, a single cell forms only one spore. Spore formation among bacteria, therefore, is not a reproductive device for multiplying the number of individuals of a species, but signifies a resistant stage, for the purpose of meeting the advent of unfavorable conditions of life. The spore is to be considered as a resting stage. It serves to tide the species over a period of dryness, famine, or unsuitable temperature, and to preserve alive in hostile environment a suitable number of individuals until such a time when favorable conditions recur. The spore stage is analagous to the periods of hibernation, or estivation among higher forms of life.

After the spore has again regained its favorable conditions for growth, it will again germinate, and reproduce like kind from which it came.

Fortunately, however, only a few of our pathogenic diseases, such as anthrax and tetanus, produce spores. This naturally facilitates and simplifies the disinfection and treatment of infectious diseases.

Bacteria are divided according to shape into cocci, bacilli and spirilla.

1. **Cocci.**—These are the rounded or the spherical form of bacteria. In this group the cells range from 0.5 to 2 microns in diameter, but most measure about 1 micron. (1 micron equals 1-25,000-inch). Before division, they may increase in size in all directions. The species are usually classified according to their mode of division.

- Germs
  - vegetable parasites
    - bacteria
      - cocci
        - micro-cocci
        - diplo-cocci
        - strepto-cocci
        - staphylo-cocci
        - tetrads
        - sarcinae
      - bacilli
        - bacilli
        - diplo-bacilli
        - strepto-bacilli
      - spirilla
        - vibrio
        - spirochaeta
    - yeasts
    - moulds
  - animal parasites

(a) *Micrococci.*—These appear singly and alone. There may be millions of them present in a small area, but each of them is independent of the others. The word micrococcus usually refers to all the classes of the cocci.

(b) *Streptococci.*—If the cells divide only in one plane or axis, and through the consistency of their envel-

Fig. 2.—Forms of Cocci. *a*, micrococci and staphylococci; *b*, streptococci; *c*, diplococci; *d*, tetrads; *e*, sarcinae.

opes remain attached, then a chain of cocci will be found. A species in which this occurs is known as streptococcus.

(c) *Staphylococci.*—If division takes place irregularly, the resultant mass may be compared to a bunch of grapes, and the species is called staphylococcus. Fig, 2, a.

(d) *Tetrads.*—Division may take place in two planes or axes at right angles to each other, in which case cocci adhere to each other in packets of four, called tetrads; or sixteen may be found, the former number being the more frequent.

(e) *Diplococci.*—The individuals in a group of mi-

crococci often show a tendency to remain united in twos. These are spoken of as diplococci. Fig. 2, c.

(f) *Sarcinae.*—Usually included in this group are coccus-like organisms which divide in three planes or axes at right angles to each other. These are usually referred to as sarcinae. They resemble a bale of cotton. If the cells are lying single they are round, but usually they are seen in cubes of eight, with the sides which are in contact, slightly flattened. Large numbers of such cubes may be lying together. The sarcinae are as a rule some larger than the other members of the group. Fig. 2, e.

2. **Bacilli.**—These are the rod-shaped form of bacteria. They consist of long or short cylindrical cells with

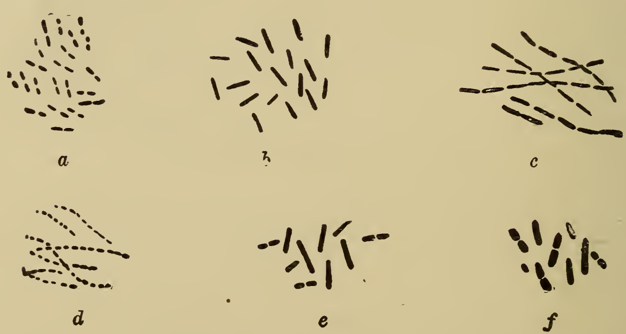

Fig. 3.—Forms of bacilli. *a*, diplobacilli; *b*, single bacilli; *c-d*. streptobacilli; *e-f*. spore forms.

rounded or sharply rectangular ends, usually not more than one micron broad, but varying very greatly in length.

They may be motile or non-motile. Where flagella

occur they may be distributed all around the organism or only at one or both of the ends of the bacillus.

A flagellum is a whip-like projection like a tail extending from the body of a bacterium, which will enable it to move by the lashing movement of the whip.

Many species have spore forms. The spores may be located centrally, or terminally, and may be round, oval or spindle shaped.

(a) *Diplobacilli.*—The individuals in a group may show a tendency to remain united in twos. These are spoken of as diplobacilli.

(b) *Streptobacilli.*—Since bacilli always divide in one plane or axis by transverse division, and because of a peculiar arrangement of the capsule, they may remain attached. A chain of bacilli will thus be found. A species in which this occurs is known as streptobacillus.

3. **Spirilla.**—Some of the elongated bacteria have a remarkable twisted form and bear some resemblance to a corkscrew. These are called spirilla.

Fig. 4.—Forms of spirilla.

(a) *Spirochaeta.*—A subdivision of spirilla, whose individuals are not only twisted, but are also very flexible, is called spirochaeta.

(b) *Vibrio.*—In this type the unit is a short curved

rod, often referred to as a "comma" or "horseshoe" shape. This type is known as vibrio.

Bacteria, Divided as to the Products They Live On.—As regards the life process of bacteria, they lead either a saprophytic or a parasitic existence.

In this regard, then, bacteria are divided as to the products they live on into either saprophytes or parasites. Each of these classes is then divided into either obligative or facultative, as the following outline will show:

Bacteria	Parasites	Obligative
		Facultative
	Saprophytes	Obligative
		Facultative

A *saprophyte* is one that grows on dead organic matter; that is, it develops without a living host.

A *parasite* is one that depends for its existence upon the conditions offered by either a living animal or plant, in or on which it develops.

Both saprophytes and parasites have their obligative and facultative forms. In this sense the term *obligate* as applied to a saprophyte implies that it can live only on dead matter.

When applied to a *parasite*, that it can develop only within a living host.

The designation *facultative*, as applied to a parasite or a saprophyte, implies that these organisms possess the power of leading either a parasitic or a saprophytic form of existence, according to the circumstances.

Bacteria, Divided as to Oxygen Supply.—Bacteria may be divided into aerobic and non-aerobic (anaerobic) classes with reference to their need of oxygen.

Bacteria	Aerobic	Facultative
		Obligative
	Non-aerobic	Facultative
		Obligative

The *obligative aerobes* are those that require free oxygen for the maintenance of their life activities.

The *obligative non-aerobes* are those that do not grow except in the almost complete absence of free oxygen.

The *facultative aerobes* or *anaerobes* are those that can thrive in either the presence or the absence of oxygen.

Bacteria Divided as to the Products They Produce.—(a) *Zymogenic bacteria.*—These products ferment. Fermentation was not due, as Liebig for a time maintained, to the presence of dead and dying yeast cells which, in the course of their own molecular disintegration, toppled over and dragged down certain complex organic molecules with which they were in contact, but on the contrary, was caused by the effort of living and growing yeast cells to satisfy their nutritional requirements.

Some of the zymogenic germs are as follows:

Bacillus acido lactis, bacillus lactis, micrococcus urea.

(b) *Saprogenic bacteria.*—These produce putrefaction. Putrefaction and decay were shown by Pasteur to be not fields for the "spontaneous generation" of life, but manifestations of chemical disintegration due to met-

abolic activities of microorganisms engaged in satisfying their need for food.

Saprophytes live inside the intestines of the human body in great numbers, surviving on the feces. Klein estimates that the feces excreted daily contain one-third their weight of saprophytes, giving us a bacterial count of between eighty-eight hundred billion and one hundred and twenty-eight trillion bacteria.

Saprophytes are the most abundant of the bacteria. They are found on the surface of the body normally and in cases of gangrene. They pass out into the tissues after death, as experiments with the guinea pig show that within thirty minutes after death bacteria find their way to the outside of the organs, while at the end of sixteen hours they have thoroughly invaded all the tissues and set up a complete state of putrefaction at a temperature of 60 degrees Fahrenheit or over.

Saprophytes are present everywhere, in the air, earth, water and food. Deep mines and high mountain tops have the smallest number, so as a rule we can never hope to escape them. They cover the skin, are in the orifices, some eighty different varieties having been found upon the hands and the feet, and under the nails. They also cover the entire alimentary canal from the mouth to the anus.

Saprophytes are given the credit of doing all the discoloration and putrefactive work upon the dead body. But little is written about the parasites that also must take a most active part in the destruction and reduction of the human body to its normal elements. Some may claim that all bacteria found in the dead body are sapro-

phytic, while others may claim that the pathogenic class are not saprogenic, but it is a fact known to every undertaker and embalmer that a case of septicemia, pyaemia, puerperal septicemia, child-birth fever, all forms of blood poisoning, erysipelas, typhoid fever and the others, all containing bacteria in the blood, go to pieces rapidly soon after death, and can only be kept in condition by using large amounts of embalming fluid. One of two conditions must exist in these cases: either the infective pathogenic bacteria cause the rapid decomposition themselves, or they have so prepared the tissues for the reception of the saprophytes, thus causing an early decomposition. There is no doubt in the writer's mind but that this latter statement is true.

Some of the saprogenic germs are as follows:

Bacillus colli communis,	Bacillus putrescens,
Bacillus termo,	Bacillus putridus,
Bacillus cadaverens,	Proteus vulgaris,
Bacillus intercellularis,	Bacillus subtillis.

(c) *Chromogenic bacteria.*—These produce color. Some of this class are as follows:

Bacillus citreus produces a yellow color.
Bacillus violescens produces a violet color.
Bacillus fluorescens produces a green color.
Orange sarcine produces an orange color.

After death there are usually discolorations which occur here and there over the body. These discolorations, which are the result of putrefactive changes, are caused by certain chromogenic bacteria which have the power to produce color. Thus over the abdomen there is a

greenish discoloration, which is caused by a certain class of putrefactive bacteria of a chromogenic nature, usually the bacillus fluorescens.

(d) *Aerogenic bacteria.*—These produce gas.

Examples of this class would be, any of the saprogenic germs mentioned in a preceding paragraph.

After a body dies, almost immediately aerogenic bacteria and putrefactive bacteria enter the tissues of the body. As a result of their fast development and multiplication under favorable conditions, putrefaction of the tissues ensues, and this is accompanied with a formation of gases which distends the different parts.

The formation of gas in the stomach and intestines is known as abdominal gas, while the formation of gas in the tissues of the body is known as capillary tissue gas, which is most marked in the tissue just beneath the skin. It must be remembered, then, that these gases are caused by aerogenic bacteria, and should the embalmer want to arrest the formation of gas he must introduce a fluid that will be germicidal to them, and the fluid must of necessity reach all the parts affected.

(e) *Photogenic bacteria.*—Many bacteria have the power to form light, giving to various objects which they inhabit a characteristic glow or phosphorescence.

Bacteria of this class are as follows: Bacillus fluorescens, bacillus phosphorescens.

The undertaker and the embalmer have no particular interest in this class of bacteria, and they are only given here to have a complete classification.

(f) *Thermogenic bacteria.*—This class of bacteria produce heat. After a body dies it is subject to decom-

position and decay, unless retarded by some external procedure. At the time of death the temperature of the body is about 96.6 degrees, but as soon as death takes place the temperature of the body gradually sinks to that of the surrounding atmosphere. It has been noted that when putrefaction sets in now, that the temperature is increased a fraction of a degree, and this is attributed by scientists to the action of germ life, and it is to this class of bacteria that the name thermogenic is given. Other than this, the undertaker and the embalmer have no special interest in this class .

(g) *Toxicogenic bacteria.*—This class of bacteria produces poison. Some examples of this class are the bacillus prodigiosus, bacillus vulgaris, spirillum rubin.

In fact almost any pathogenic bacterium, when it once gains entrance to the human body, produces as a result of its growth and development under favorable conditions certain poisons or toxins which are considered harmful to the human body, and this results in a particular disease or toxemia.

These toxicogenic bacteria abound everywhere, and it is for this reason that undertakers and embalmers should be careful while operating on a dead body so as not to cut themselves. But if this accident should occur the best thing to do is to squeeze out all the blood possible from the wound and then place the part in embalming fluid and wrap up the part with a clean bandage saturated with the formaldehyde fluid. Then later, should the wound show signs of any future trouble, a physician should be consulted at once.

(h) *Pathogenic bacteria.*—These produce disease.

Some of the pathogenic bacteria are as follows:

Bacillus diphtheriae,	causing	diphtheria.
Bacillus influenzae,	"	influenza.
Bacillus Koplik,	"	whooping cough.
Bacillus anthracis,	"	anthrax.
Bacillus pestis,	"	bubonic plague.
Bacillus mallei,	"	glanders.
Bacillus lepra,	"	leprosy.
Bacillus tetani,	"	tetanus.
Bacillus typhosus,	"	typhoid fever.
Bacillus tubercle,	"	tuberculosis.
Tetrad of mumps,	"	mumps.
Spirillum of cholerae,	"	cholera.
Gonococcus,	"	gonorrhea.
Etc.		

Pathogenic microorganisms, such as tubercle bacilli and the pyogenic cocci, have been found in the air of hospitals and sick-rooms, but as a rule pathogenic bacteria in the dry dust are of rare, rather than of frequent occurrence.

Yeasts.—Yeasts are fungi that are characterized especially by a mode of division or multiplication, called budding.

The cells are spheroid in shape or egg-shaped in form, and possess well-defined cell walls. They are much larger than the bacteria. All true yeasts form spores under suitable conditions. The usual number of spores is four, but some yeast like organisms have been found with eight spores. Yeast spores are quite common in the atmosphere and in some situations outnumber the bacteria.

Yeasts have long been known for their ability to produce alcoholic fermentation, and the technical study of these organisms has been chiefly carried on in connection with brewing and other practical operations. A variety

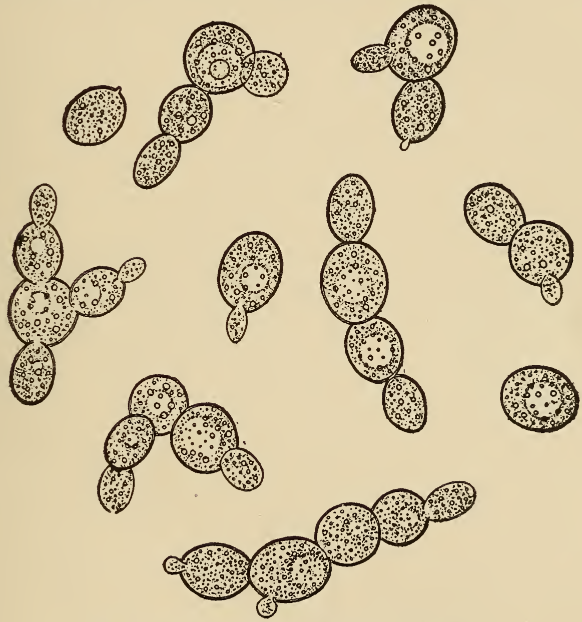

Fig. 5.—Yeast cells (Sedgwick and Wilson).

of familiar processes, such as the raising of dough, are effected through their agency.

Pathogenic Yeasts.—The study of the pathogenic yeasts dates practically from the discovery by Busse in 1894 of a generalized fatal infection apparently caused by a yeast. Certain skin diseases are caused by yeasts. A disease of the mouth, known as parasitic stomatitis or thrush, is caused by a yeast.

Moulds.—Mould is the white, cottony appearance which may be seen on damp bread, on jellies and preserves, etc. They are fungi which reproduce by end or threadlike growth, each thread or filament interwinds and interlaces with other filaments, producing the matted feltlike appearance.

The spores of moulds are everywhere, and are usually more abundant than bacteria in ordinary air. Mould is the source of the so-called potato-rot, and grain infected with mould causes poisoning in man called ergotism. Most moulds are parasites for higher plants.

A small number have pathogenic properties for the higher animals, including man. Certain abscesses found in the lungs, peritoneal cavity and brain, due to moulds, are fatal. The skin affection usually known as ringworm is also caused by a mould. This infection is communicable from man to man, and may also be contracted from the horse, cat, dog and other domestic animals.

Moulds are also quite frequent and common in the atmosphere, and are frequently a source of trouble to the housekeeper from their tendency to attack fruit, preserves and similar substances.

Bodies placed in receiving vaults and other temporary places are subject to the formation of mould on the face. As a preventive treatment, vaseline (petrolatum), is applied to the skin. This can be removed again before the body is shown.

As a curative treatment, grain alcohol and acetic ether are used on a piece of cloth, and the mould is removed by rubbing. This treatment also dries the skin and

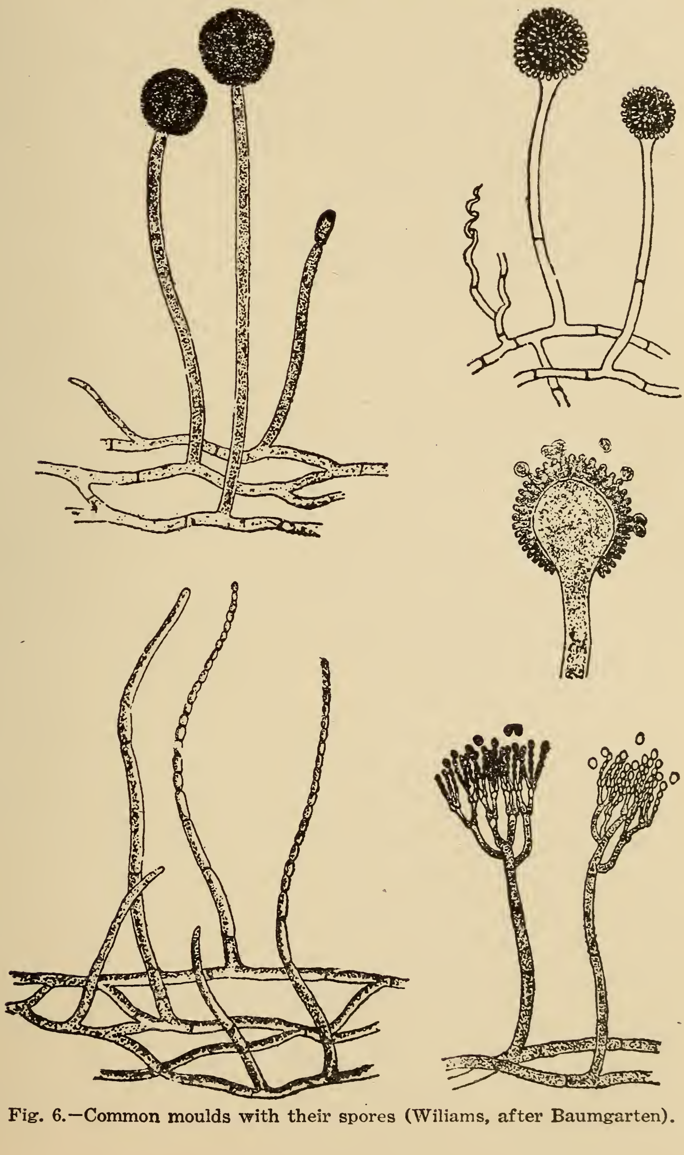

Fig. 6.—Common moulds with their spores (Wiliams, after Baumgarten).

prevents a recurrence of the mould for some time. It is sometimes necessary to use a scalpel to scrape the mould. This should never be done, however, unless the solution is used first.

Formula for the solution:

Rx. { Grain alcohol / Acetic ether } Equal parts.

PART II.

THE CAUSATION, MODES OF DISSEMINATION AND SPREAD OF SPECIAL DISEASES.

CHAPTER IV.

DISEASE DESCRIPTION.

Disease.—Disease is the opposite of "ease," or any abnormal condition of the body.

Only one in every forty persons dies of old age. About twice that number meet death by accident, while disease is responsible for over nine-tenths of the mortality of the human race.

The numerous diseases affecting man may be divided into two classes, known as infectious and non-infectious.

- Disease
  - Infectious or Communicable
    - Contagious
    - Non-contagious
  - Non-infectious or Non-communicable.

Non-infectious diseases result from a disturbance of the functions of any one of the organs of the body through natural causes.

Imperfect nutrition and imperfect circulation of the blood, as well as the presence of poisons formed within

the body, will also cause diseases that can not be transmitted from one person to another. Headache, toothache, neuralgia, alcoholism, diabetes, insanity, cancer, etc., are examples of non-infectious diseases.

Infectious diseases are caused by tiny plants or animals, called parasites, feeding upon the human body, which is their host. These parasites, the smallest of which are commonly called microbes or germs, make one ill, chiefly by means of their poisonous excretions. In Europe and America 60,000,000 people are annually laid prostrate by infectious diseases, which result in over 3,000,000 deaths.

Infectious diseases result from the presence and reproduction of pathogenic germs within the healthy body. *Infection* is the communication of disease from one person to another by direct or indirect contact or inoculation. *Contagion* is the process of transfer of specific diseases. Contagium is the name usually given to the morbific matter or virus which actually causes the disease. It is the thing which is transferred. *Inoculation* is the introduction of specific virus into the system through an abrasion of the skin.

As here employed, the term infectious refers especially to the morbific agents causing disease, and implies nothing as to the mode of transmission of these agents. It is evident that the term infection, as relating to the causation of disease, is broader than the word contagious, which relates only to the manner of transmission. The term infectious disease is usually understood as distinct from contagious; infectious diseases are disseminated indirectly, i.e., in a roundabout way, by means of

food, water or soil, and enter the body by means of the digestive tract; also by inoculation by means of insects, such as flies, fleas, mosquitoes, etc.

All communicable diseases are infectious, whether or not an infectious disease is contagious in the ordinary sense, depends upon the nature of the infectious agent, and especially upon the manner of its elimination from and reception by the body.

Infectious diseases are divided into contagious and non-contagious diseases. A *contagious* disease is one transmissable from individual to individual by immediate or direct contact; the infectious agent is usually carried by means of the atmosphere, and enters the second body by means of the respiratory system. Such infectious ailments as consumption, smallpox and scarlet fever, which may be contracted by breathing the germs floating in the air, are called contagious because the healthy acquire the disease by coming near where the sick are or have been. All contagious diseases are also infectious and are dependent upon the activities of vital pathogenic agents in the tissues.

Maladies like yellow fever, lockjaw and malaria belong to the group of *non contagious* diseases, for the reason that persons living in the same house and even sleeping in the same bed with the sick do not become ill unless a mosquito or a sharp instrument conveys the germs from the sick to the well.

The characteristics of communicable diseases, as to their manner of transmission, gives rise to another form of classification.

Endemic diseases are those peculiar to a people or a

nation, occurring naturally in a certain district. Asiatic cholera, occurring naturally about the delta of the Ganges river in India, is an example.

Sporadic diseases are those that are scattered, occurring here and there at irregular intervals. Cerebro-spinal meningitis, or any of the communicable diseases, could be classed as sporadic, providing they occur according to this definition. In this instance each of the cases is isolated from the other.

Epidemic diseases are those that affect a large number of people in a certain community and where it seems probable that the disease has been induced by the same source of infection. The typhoid epidemic would be an example of epidemic disease.

A *pandemic disease* is one affecting two or more countries or nations at the same time. The prevalence of influenza in temperate latitudes would be an excellent example of a pandemic disease.

The descriptive terms applied to diseases are as follows:

An *acute* disease is one that runs a rapid, short and severe course.

A *chronic* disease is one that runs a long, less rapid and less severe course.

A *specific disease* is one where the cause and origin is known.

A *non-specific disease* is one where the cause and origin is not known.

A *self-limited disease* is one that limits itself, or where it is known how long it will take for the patient to get well.

An *unlimited disease* is one where we do not know how long it will take for the patient to get well.

The Discovery of what causes Disease.—Several hundred years ago disease was thought to be due to evil spirits which took up their abode in the body. Here they produced continuous suffering until driven out by various devices such as beating the patient with a strap or giving him so-called medicine consisting of powdered human bones. Although for fifty years it had been thought by some that many diseases were due to bacteria, yet the fact that each of certain diseases is caused by a particular bacterium was not clearly proven until 1876. In that year Louis Pasteur, of France, showed that anthrax, a sickness of cattle, was caused by a rod-like plant. He secured a few of these plants from the blood of a sick cow, and planted them in broth, where they increased rapidly in number. A few were then injected under the skin of a healthy cow, which soon afterward became sick. In her blood the same plants were found in vast numbers. Dozens of similar experiments and the presence of these particular plants and no others in the blood of all animals with anthrax, have made it certain that the disease is caused by this specific germ. In a similar manner or by some other equally reliable method it has been shown that each of the following ailments is produced by its own particular kind of germ: diphtheria, typhoid fever, malaria, pneumonia, leprosy, tetanus, hydrophobia, influenza, erysipelas and tuberculosis, etc.

There are a number of diseases that are infectious, and therefore in all probability due to some microorganism, but concerning the actual causation of which there

is at present either much difference of opinion among competent observers or absolute uncertainty. Those of this class are as follows: smallpox, hydrophobia, yellow fever, whooping cough, scarlet fever, measles, foot and mouth disease, Rocky Mountain spotted fever, mumps and infantile paralysis.

Inasmuch as all infectious diseases may be prevented by keeping the germ out of the body, much effort has been made to study how they gain entrance.

How Germs enter the Body.—The germs of any contagious disease may be taken in by breathing, but other channels of infection are also known. Influenza (or grippe), pneumonia, diphtheria, sore throat and whooping cough are no doubt often contracted by a healthy person drinking from the same cup lately used by those just recovering from sickness. Numerous disease germs as well as harmless ones are present in the sputum of such patients. By examining with the microscope, a glass touched by the lips has been found to contain over 20,000 bacteria. One single touch of the finger, moistened with saliva to aid in turning the pages of a book, might contain over 5,000 germs. The fingers touching the soiled books, clothing, pencils or instruments used about the sick-room or dead body, may convey the germs to the mouth. The number of days elapsing from the time the germs enter the body to the time when the disease appears, is known as the *incubation period*. Other disease germs might get into the body by direct inoculation, as for example in tetanus, where infection is brought into the body by stepping on a rusty nail; or in yellow fever,

where the animal parasite is directly inoculated into the body with the bite of a mosquito.

The manner of their introduction into the body is as follows:

(a) Direct contact. Through contact of infected organs or parts with non-infected organs or parts. Through the instrumentality of infected materials—sponges, instruments, cloths, books, etc.—which have been in contact with the infected persons and subsequently in contact with non-infected persons.

(b) Through the inspired air. It is doubtful if organisms enter free and unassociated with the inspired air into the body. It is undoubtedly true that organisms generally cling to or are in some material. Fine particles of any material—solid, semi-solid or fluid—may be the carrier of organisms into the body through the inspired air. The air itself, clear of these particles, is sterile, and is also sterile if these particles are sterile.

(c) With food and drink. The most frequent sources of some diseases are water contamination, uncooked and improperly cooked food of all kinds, the infected flesh, blood, organs or products of infected animals, etc.

(d) With infected materials through the urethra, vagina or rectum.

(e) With bites from intermediate hosts, such as flies, mosquitoes, rats, fleas and other animals.

(f) With the male and female cells of generation.

Their Distribution in the Body.—The infection may be local or general. A local infection is limited to the place of introduction. A general infection embraces more or less all the body or some particular system, and the blood. Auto-infection is a growth and spread of bacteria

in the body, and the manner is as follows: Continuity of tissues or organs; through the lymphatics; by the leucocytes or white blood cells; from one organ to another by the transportation of the infected material, e.g., swallowed sputum bringing about tuberculosis of the bowels; the urine from a tubercular kidney bringing about the same disease of the bladder.

Lesions Produced.—There is a vast difference in the effects produced by different bacteria. A classification may be made as follows:

(a) Those which produce little or no local lesions, as for example the tetanus bacillus.

(b) Those which produce some characteristic inflammatory product, such as the membranes produced in diphtheria.

(c) Those which peptonize the tissue and form pus, as for example the pyogenic organisms; those which destroy in mass the tissue, forming sloughs, such as certain kinds of phlegmonous inflammations.

(d) Those which create new tissue by cell proliferation or growth, which subsequently degenerates, such as the tubercle.

(e) Those which circulate in the blood, producing no lesion, such as the anthrax bacilli.

Toxins and Anti-toxins Produced and their Effects.—All bacteria produce toxins, and some at least anti-toxins which either neutralize the toxins or destroy the bacteria. The self-limitation of most of the acute infectious diseases is explained in this way. For this reason anti-toxin is greatly used for the prevention of certain diseases, such as diphtheria, anthrax, tetanus, hydrophobia, etc. A toxin is a poison produced by bacteria. An anti-

toxin is a substance developed in a body and which has the power of counteracting a poison.

The Manner of their Elimination or Discharge from the Body.—The manner in which bacteria may leave the body and pass into the outer world is one of transcendent importance in the prevention of disease. The following is a summary of the methods by which bacteria may leave the body:

(a) In the discharge from infected organs, as for example, the sputum, the feces, urine, pus, secretions, etc.

(b) In droplets of condensed vapor of the breath.

(c) Solid, semi-solid, or liquid particles from the skin.

(d) On the skin appendages, hair and nails.

(e) In the blood in hemorrhagic conditions.

(f) Through the instrumentality of insects which feed upon or come in contact with secretions, feces, urine, etc., or suck the blood from infected persons.

The Life History of Bacteria outside of the Body.—If bacteria all died as soon as eliminated from the body, or if they were thereby rendered harmless, preventive medicines would be greatly simplified. Unfortunately, however, such is not the case. The most of the epidemics are caused by facultative bacteria, which contaminate the soil, water, and food, as for example, the bacteria causing typhoid fever, cholera, dysentery, etc. Some bacteria do not multiply outside of the living host, but may survive as individuals for considerable periods. Some not only survive, but are capable of multiplying indefinitely, thereby maintaining the species under purely saprophytic conditions. Some require an intermediate host for their perpetuation under ordinary conditions, such as the parasites causing malarial fever.

CHAPTER V.

THE CORRECT NAMES FOR THE CAUSES OF DEATH AS LISTED BY THE INTERNATIONAL LIST OF CAUSES OF DEATH.

The undertaker for a long time has been desirous of getting the accurate names which should appear on the death certificates.

Recently the different countries have gotten together in conference, and have formulated what is known as the International list of causes of death. All physicians now, in signing death certificates, are compelled by law to assign as the cause of death a name which is recognized by this International list.

We have therefore appended this list so that the undertaker may have an exact list of the causes of death as they will occur on the death certificate when handed to him.

Many of these names are scientific, some of which we have taken up and described as to treatment in "Anatomy and Embalming," Nunnamaker-Dhonau. Those which are not described can be found in Gould's Medical dictionary.

Every practicing embalmer should own a dictionary of this kind for reference in case diseases are mentioned in the certificate or by the physician with which the

embalmer is not familiar. It is widely recognized that some knowledge of the nature and location of the disease should be had by the embalmer so that his treatments may be directed in the proper manner.

The following is the list of the causes of death as they will appear on the death certificate and are taken from the International list of causes of death.

I.—GENERAL DISEASES.

1. Typhoid fever.
2. Typhus fever.
3. Relapsing fever.
4. Malaria.
5. Smallpox.
6. Measles.
7. Scarlet fever.
8. Whooping cough.
9. Diphtheria and croup.
10. Influenza.
11. Miliary fever, (Febris miliaris.)
12. Asiatic cholera.
13. Cholera nostras.
14. Dysentery.
15. Plague.
16. Yellow fever.
17. Leprosy.
18. Erysipelas.
19. Other epidemic diseases:
    Mumps,
    German measles,
    Chicken-pox,
    Rocky Mountain spotted (tick) fever,
    Glandular fever, etc.
20. Purulent infection and septicæmia.
21. Glanders.
22. Anthrax.
23. Rabies.
24. Tetanus.
25. Mycoses, Actinomycosis of lung.
26. Pellagra.
27. Beriberi.
28. Tuberculosis of the lungs.
29. Acute miliary tuberculosis.
30. Tuberculous meningitis.
31. Abdominal tuberculosis.
32. Pott's disease, (tuberculosis of spine.)
33. White swellings, (tuberculosis of — joint.)
34. Tuberculosis of other organs.
35. Disseminated tuberculosis.
36. Rickets.
37. Syphilis.
38. Gonococcus infection.
39. Cancer of the buccal cavity.
40. Cancer of the stomach, liver.
41. Cancer of the peritonæum, intestines, rectum.
42. Cancer of the female genital organs.
43. Cancer of the breast.
44. Cancer of the skin.
45. Cancer of other or unspecified organs.

46. Other tumors (tumors of the female genital organs excepted.)
47. Acute articular rheumatism.
48. Chronic rheumatism and gout.
49. Scurvy.
50. Diabetes.
51. Exophthalmic goitre.
52. Addison's disease.
53. Leuchæmia.
54. Anæmia, chlorosis.
55. Other general diseases:
    Diabetes insipidus,
    Purpura hæmorrhagica,
56. Alcoholism (acute or chronic).
57. Chronic lead poisoning.
58. Other chronic occupation poisonings:
    Phosphorus poisoning (match factory),
    Mercury poisoning (mirror factory), etc.
59. Other chronic poisonings:
    Chronic morphinism,
    Chronic cocainism, etc.

II.—DISEASES OF THE NERVOUS SYSTEM AND OF THE ORGANS OF SPECIAL SENSE.

60. Encephalitis.
61. Meningitis:
    Cerebro-spinal fever or Epidemic cerebro-spinal meningitis.
    Simple meningitis.
62. Locomotor ataxia.
63. Other diseases of the spinal cord:
    Acute anterior poliomyelitis,
    Paralysis agitans,
    Chronic spinal muscular atrophy,
    Primary lateral sclerosis of spinal cord,
    Syringomyelia, etc.
64. Cerebral hæmorrhage, apoplexy.
65. Softening of the brain.
66. Paralysis without specified cause.
67. General paralysis of the insane.
68. Other forms of mental alienation.
69. Epilepsy.
70. Convulsions (non-puerperal.)
71. Convulsions of infants.
72. Chorea.
73. Neuralgia and neuritis.
74. Other diseases of the nervous system.
75. Diseases of the eyes and their annexa.
76. Diseases of the ears.

III.—DISEASES OF THE CIRCULATORY SYSTEM.

77. Pericarditis. (Acute or chronic; rheumatic.)
78. Acute endocarditis. (Cause?)
79. Organic diseases of the heart.
    Chronic valvular disease,
    Aortic insufficiency,
    Chronic endocarditis,
    Fatty degeneration of heart, etc.

80. Angina pectoris.
81. Diseases of the arteries, atheroma, aneurysm, etc.
82. Embolism and thrombosis.
83. Diseases of the veins (varices, hæmorrhoids, phlebitis, etc.)
84. Diseases of the lymphatic system (lymphangitis, etc.)
85. Hæmorrhage.

IV.—DISEASES OF THE RESPIRATORY SYSTEM.

86. Diseases of the nasal fossæ.
87. Diseases of the larynx.
88. Diseases of the thyroid body.
89. Acute bronchitis.
90. Chronic bronchitis.
91. Broncho-pneumonia.
92. Pneumonia.
93. Pleurisy.
94. Pulmonary congestion, pulmonary apoplexy.
95. Gangrene of the lung.
96. Asthma.
97. Pulmonary emphysema.
98. Other diseases of the respiratory system.

V.—DISEASES OF THE DIGESTIVE SYSTEM.

99. Diseases of the mouth and annexa.
100. Diseases of the pharnyx.
101. Diseases of the œsophagus.
102. Ulcer of the stomach.
103. Other diseases of the stomach.
104. Diarrhœa and enteritis. (under 2 years.)
105. Diarrhœa and enteritis.
106. Ankylostomiasis (Hookworm.)
107. Intestinal parasites.
108. Appendicitis and typhlitis.
109. Hernia.
110. Other diseases of the intestines.
111. Acute yellow atrophy of the liver.
112. Hydatid tumor of the liver.
113. Cirrhosis of the liver.
114. Biliary calculi.
115. Other diseases of the liver.
116. Diseases of the spleen.
117. Simple peritonitis.
118. Other diseases of the digestive system.

VI.—NON-VENEREAL DISEASES OF THE GENITO-URINARY SYSTEM AND ANNEXA.

119. Acute nephritis.
120. Bright's disease. Chronic Bright's disease, interstitial nephritis, Chronic parenchymatous nephritis, etc.
121. Chyluria.
122. Other diseases of the kidneys and annexa.
123. Calculi of the urinary passages.
124. Diseases of the bladder.
125. Diseases of the urethra, urinary abscess, etc.

126. Diseases of the prostate.
127. Nonvenereal diseases of the male genital organs.
128. Uterine hæmorrhage.
129. Uterine tumor (noncancerous.)
130. Other diseases of the uterus.
131. Cysts and other tumors of the ovary.
132. Salpingitis.
133. Nonpuerperal diseases of the breast.

VII.—THE PUERPERAL STATE.

134. Accidents of pregnancy.
    Abortion, Criminal abortion,
    Miscarriage,
    Ectopic gestation,
    Tubal pregnancy, etc.
135. Puerperal hæmorrhage.
136. Other accidents of labor.
    Cæsarean section,
    Forceps application,
    Breech presentation,
    Symphyseotomy,
    Difficult labor.
    Rupture of uterus in labor, etc.
137. Puerperal septicæmia.
138. Puerperal albuminuria and convulsions.
139. Puerperal phlegmasia alba dolens, embolus, sudden death.
140. Following childbirth.
141. Puerperal diseases of the breast.

VIII.—DISEASES OF THE SKIN AND CELLULAR TISSUE.

142. Gangrene.
143. Furuncle.
144. Acute abscess.
145. Other diseases of the skin and annexa.

IX.—DISEASES OF THE BONES AND OF THE ORGANS OF LOCOMOTION.

146. Diseases of the bones.
    Osteoperiostitis.
    Osteomyelitis,
    Necrosis,
    Mastoiditis, etc. (Following Otitis media.)
147. Diseases of the joints.
    Acute articular rheumatism,
    Arthritis deformans,
    Tuberculosis of — joint.
148. Amputations.
149. Other diseases of the organs of locomotion.

X.—MALFORMATIONS.

150. Congenital malformations.
  Congenital hydrocephalus,
  Congenital malformation of heart,
  Spina bifida.

XI.—DISEASES OF EARLY INFANCY.

151. Congenital debility, icterus, and sclerema:
  Premature birth,
  Atrophy,
  Marasmus,
  Inanition, etc.
152. Other diseases peculiar to early infancy:
  Umbilical hæmorrhage,
  Atelectasis,
  Injury by forceps at birth, etc.
153. Lack of care.

XII.—OLD AGE.

154. Senility.

XIII.—AFFECTIONS PRODUCED BY EXTERNAL CAUSES.

155. Suicide by poison.
156. Suicide by asphyxia.
157. Suicide by hanging or strangulation.
158. Suicide by drowning.
159. Suicide by firearms.
160. Suicide by cutting or piercing instruments.
161. Suicide by jumping from high places.
162. Suicide by crushing.
163. Other suicides.
164. Poisoning by food.
165. Other acute poisonings.
166. Conflagration.
167. Burns, scalding.
168. Absorption of deleterious gases:
  Asphyxia by illuminating gas (accidental),
  Inhalation of — (accidental),
  Asphyxia (accidental),
  Suffocation (accidental).
169. Accidental drowning.
170. Traumatism by firearms.
171. Traumatism by cutting or piercing instruments.
172. Traumatism by fall.
173. Traumatism in mines and quarries:
  Fall of rock in coal mine,
  Injury by blasting, slate quarry.
174. Traumatism by machines.
175. Traumatism by other crushing.
  Railway collision,
  Struck by street car,
  Automobile accident,
  Run over by dray,
  Crushed by earth in sewer excavation, etc.
176. Injuries by animals.

177. Starvation.
178. Excessive cold. (Freezing.
179. Excessive heat. (Sunstroke.)
180. Lightning.
181. Electricity.
182. Homicide by firearms.
183. Homicide by cutting or piercing instruments.
184. Homicide by other means.
185. Fractures.
186. Other external causes:
   Legal hanging,
   Legal electrocution.

XIV.—ILL DEFINED DISEASES.

187. Ill defined organic diseases:
   Dropsy,
   Ascites.
188. Sudden death.
189. Cause of death not specified or ill defined.

CHAPTER VI

DISINFECTION FOR THE COMMUNICABLE DISEASES.

THE NON-CONTAGIOUS DISEASES.

Anthrax.—This is a communicable disease occurring as a wide spread infection of the lower animals and occasionally communicated to man. This disease is often called malignant pustule, splenic fever, wool-sorter's disease.

The infection is introduced into the skin and a local reaction results causing the malignant pustule. The inflammation spreads through the lymphatics and invades the blood. When the infection is taken into the respiratory tract it causes a violent inflammation resembling bronchitis or pneumonia, and is called wool sorter's disease. Sometimes the infection is taken into the intestinal tract, producing symptoms of an intense poisoning. All the forms of this disease frequently result fatally.

The disease is caused by the bacillus anthracis, which is one of the few disease producing germs that produce spores.

The infection usually enters the system through fissures, abrasions, or wounds of the skin, which is especially apt to take place upon the exposed surface—the hands, face and arms—of those who work with hides and

other infected objects. The infection may also be taken into the digestive tract as a result of eating meat or drinking milk, of the diseased animal. The third channel through which the infection may enter the system is through the respiratory system.

The infection of anthrax is eliminated from the body in the pus and discharges from the vesicles, carbuncles, and broken down tissue which are frequently found associated with the disease. The pulmonary form of the infection is eliminated from the body in the expectoration.

In the intestinal variety the discharges from the bowels contain the infective agent. The infection has been conveyed by flies probably in the same way that these insects spread the infection of typhoid fever.

The bacillus of anthrax itself is readily killed, but the spores have a high degree of resistance to heat and chemical agents, so that much more powerful disinfectants are required for the non-spore bearing bacteria. The disinfection of anthrax is one of the most difficult problems with which we have to deal.

A dry heat of 100 degrees C. continued for one hour is necessary to kill spores. As far as moist heat is concerned, nothing less than boiling water or steam at 100 degrees C. can be considered trustworthy, and then with an exposure of two hours. Anthrax spores may be killed with superheated steam with certainty and this is the most trustworthy method of dealing with the infection. An exposure to steam at 120 degrees C. for fifteen minutes, is quite sufficient.

Formaldehyde gas and sulphurous acid gas are incapable of destroying the infection with certainty and

are therefore totally unreliable. A 1:500 solution of bichloride of mercury acts more quickly and should be used in dealing with this infection. Carbolic acid can not be depended upon to destroy the spores of anthrax, and therefore is not applicable for disinfection against the disease. Tricresol in 2 per cent. solution or lysol in 2 per cent. solution may be used. It requires a 33 per cent. solution of formalin (containing 40 per cent. formaldehyde) to destroy anthrax spores in fifteen minutes. The strengths of the disinfecting solutions here given are based upon their germicidal action at ordinary temperatures. Their power is very much increased by using them hot, and it is recommended always to use these solutions at or as near the boiling point as possible.

All bandages, dressings and other objects of little value should be burned as the best means of disinfection. Bedding, clothing, and other objects that have become contaminated by the discharges, should be first placed in one of the germicidal solutions, for at least an hour and then boiled.

The disinfection of cadavers or carcasses dead of anthrax is a very important and difficult matter. The infection may live for years in the soil, which becomes contaminated from the bodies of animals even when deeply buried. The worms have been known to bring us the spores in their intestinal canal to the surface, thereby giving rise to fresh infection after the lapse of a very long time. Cremation is the best method of disposing of the bodies dead of anthrax.

When a body dies of this disease and it is to be shipped, it should be prepared according to Rule No. 2, of the rules

and regulations of the boards of health and the baggage men's association.

Epidemic Cerebro-Spinal Meningitis.—This is a communicable disease occurring in very fatal epidemics. It is an inflammation of the meninges of the brain and the cord and gives rise to a great variety of symptoms.

The cause of the infection is the meningiococcus, or diplococcus intracellularis meningitidis. It has no spores. Little is known as to the spread of the disease. It is evidently not directly contagious from the sick to the well, nor is the infection transmitted upon the clothing.

So little is known of the existence of the infection in nature outside of the body and the channels through which it gains entrance into the system that we can not apply our disinfectants with any assurance of limiting the spread of the disease. Our hope in a case like this is to practice a general disinfection of all the discharges, and all the objects that come in contact with the patient, and to give the room a general fumigation with formaldehyde after the termination of the case. The windows should be screened against insects. In this way all the known principles of disinfection are applied with the expectation that one will do the work. The embalmer should spray his nose and mouth with an alkaline-oil solution, which can be furnished by any druggist. Spraying should be done before embalming and after the process of embalming has been completed.

When a body dies of this disease and it is to be shipped, it should be prepared according to Rule No. 2.

Erysipelas.—Erysipelas is a communicable disease, sometimes occurring in epidemics. It is characterized by

a special inflammation of the skin, with a fever and all the characteristics of an acute infection.

The period of incubation is usually from three to seven days.

The cause of the disease is the streptococcus erysipelatis, or the streptococcus pyogenes. Fehleisen first obtained this organism from the skin of cases of erysipelas in 1883. This organism does not have spores. It is always found in the inflamed region, especially in the spreading zone of the inflammation. The organism usually remains localized at the seat of the lesion, but it may invade the blood and with its toxin give rise to serious and often fatal complications.

It is believed that the infection of erysipelas always enters the system through the wounds in the skin or mucous membranes. These wounds may be such slight fissures or abrasions as not to be visible to the naked eye.

The infection is eliminated from the body in the pus and secretions from the seat of the inflammation and perhaps also in the desquamating skin from the inflamed area. Outside the body the streptococcus of erysipelas is a very frail organism. It dies and loses its virulence very quickly when dried, especially in the sunshine. It is very susceptible to heat and to antiseptics. It is killed by a moist temperature of between 52 and 54 degrees C. in ten minutes. Boiling water or steam at a temprature of 100 degrees Centigrade destroys the infection at once.

Formaldehyde and sulphurous acid gas are very efficient gases to employ for fumigation where erysipelas has been, and should be used in the strengths and time as stated for these chemicals.

The germ is also destroyed by the ordinary germicidal solutions in the strengths for the destruction of the non-spore-bearing germs, as for example, bichloride of mercury 1 : 1000, carbolic acid 3 to 5 per cent., tricresol 1 per cent., formalin 3 to 5 per cent.

The bandages and other dressings from a case of erysipelas should be burned or thoroughly boiled. The bedding, towels, and other fabrics that have come in contact with the patient, or the infection must be boiled, steamed or immersed in one of the germicidal solutions. The hands of the nurse, and all objects that have in any way come in contact with the infected secretions must be disinfected by the methods appropriate for each object.

Rooms that have become contaminated with the infection of erysipelas, should be given a disinfection with one of the gases, followed by a thorough cleansing.

When a body dies of this disease and it is to be shipped, it should be prepared according to rule No. 2 of the rules and regulations of the boards of health and the baggage men's association.

Glanders.—This is a widespread, communicable disease of horses, mules, asses, and other animals. It is occasionally communicated to man. In both man and horses it is remarkable for its fatality.

The disease is characterized by the formation of inflammatory nodules, either in the mucous membranes of the nose (glanders), or in the skin (farcy). The period of incubation is from three to four days.

The cause of this disease is the bacillus mallei, which does not have spores.

The infection may be introduced into the system either

through the skin or the mucous membranes of the respiratory tract. In the former case the disease is usually communicated from the horse to man by contact with the infected discharges, which gain entrance into the system through wounds in the skin, giving rise to the form of infection known as farcy. The disease may also be communicated from man to man.

The inflammatory processes which characterize the disease have a tendency to break down, causing ulcers and abscesses, and the infection is eliminated from the body in the pus and the secretions from the seat of the lesions.

The manner of disinfection would be the same as that described for diphtheria and tuberculosis and need not be repeated here.

When a body dies of this disease and it is to be shipped, it should be prepared according to rule No. 2 of the rules and regulations of the boards of health and the baggage men's association.

Gonorrhea.—There is a specific inflammation of the mucous membrane of the urethra in the male and of the urethra, cervix uteri, and the glands of Bartholini in the female. This disease is caused by a micrococcus discovered by Neisser, and commonly known as the "gonococcus of Neisser."

When kept at body temperature artificial cultures of this organism have been observed to retain their vitality for as long as a month; whereas at ordinary room temperature they die in about forty-eight hours. The germ is destroyed in a few hours by drying. The germ is nonpathogenic for animals.

When a body dies with this disease, or some other disease, but there is evident signs of gonorrhea, the body should be washed off with a bichloride of mercury solution, of a 1 : 1000 strength, and pay special attention to the genitalia, to see that they are well disinfected. It is best to use rubber gloves in handling a case where gonorrhea is present.

When a body dies of this disease and it is to be shipped it should be prepared according to rule No. 3.

Hydrophobia.—A specific infectious disease communicable from animals to animals and from animals to man, commonly by a bite.

In animals this disease is known as rabies, while in man it is known as hydrophobia.

The period of incubation of hydrophobia ordinarily varies from about six weeks to two months according to circumstances.

The preventive treatment is (1) the immediate destruction of all dogs known to be suffering from this disease, and the isolation and careful observation of all animals that may have been bitten by such dogs.

(2) The seizure and destruction of all vagrant dogs.

(3) The imposition of a tax on all dog owners.

(4) The compulsory muzzling of all dogs during the prevalence of this disease.

(5) Preventive inoculation.

When handling a subject that has died of this disease, the embalmer should see that the blood which may be drawn from a body is disinfected, and should wear rubber gloves, to prevent any poison getting into his system through an abrasion of the skin, or an accidental cut.

When a body dies of this disease and is to be shipped it should be prepared according to Rule No. 3.

Relapsing Fever.—This disease, sometimes called famine fever, or seven-day fever, is a communicable disease and sometimes epidemic in form. The disease is common in India, and has from time to time extended into Europe. In 1869 it prevailed as an epidemic in New York and Philadelphia, but since then has not occurred in epidemic form in this country.

The disease is characterized by sudden onset with a chill, followed by a fever lasting about one week. There is then an intermission of about the same length of time, only to be followed by a repetition of the first febrile paroxysm. These relapses, from which the disease takes its name, may repeat themselves as many as five times.

The incubation period is from five to seven days.

Relapsing fever is caused by the spirochaeta Obermeieri, discovered by Obermeier in 1873.

The channels of entrance into and elimination from the body are not known. In this disease, as with typhus fever, sanitation seems to be more important than disinfection.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Syphilis.—This is a chronic, infectious disease, characterized by manifold pathological lesions, of which the chancre, the mucous patch, and the gumma are the most destructive.

The cause of the disease is said to be the spirochaete pallida, a very small spiral-shaped organism.

In a vast majority of cases, both gonorrhea and syph-

ilis are disseminated through actual contact with the secretions of diseased tissue during sexual intercourse. Syphilis may be disseminated, in addition to the usual way, through kissing and through the use of drinking and eating utensils that have been used by persons suffering from syphilitic lesions of the mucous membranes of the mouth. The embalmer may contract this disease in the handling of his subject.

After death the body should be thoroughly washed with a bichloride of mercury solution at least 1 : 1,000 in strength, and the operator should use rubber gloves while handling and operating on the subject.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Tetanus.—Tetanus is a communicable disease, prevalent in certain localities, and sometimes occurring in epidemic form in institutions, camps, or among the newly-born children.

The disease is characterized by cramps of the voluntary muscles, beginning with the muscles of the jaw, which gives the name of lockjaw or trismus to the affection.

The period of incubation is usually within ten days.

This disease is caused by the tetanus bacillus, first isolated by Kitasato in 1889. It has spores, which are usually small, round and appearing upon one end of the bacillus, and giving it the shape of a pin. The spores become detached from the bacilli, and have an independent existence and a very high degree of resistance to heat, germicidal agents and external influences. Under favorable conditions, such as the presence of moisture and albu-

minous matter and the absence of oxygen, the spores are capable of germinating into bacilli.

The disease is always contracted through wounds, which may be of trifling nature. Deep or punctured wounds are more apt to develop tetanus, because the oxygen of the air prevents the development and activity of the organism should it lodge upon the surface. There is very little reaction or inflammation set up at the seat of the inoculation. The organism germinates and multiplies locally in the wound without invading the blood or the deeper tissues.

The symptoms of the disease result from the formation of a poison called the tetanus toxin, which is absorbed into the system and produces its baneful action upon the nervous matter. The toxin of tetanus, which is produced by the growth and multiplication of the bacillus within and without the body, is one of the most violent poisons known. An infinitesimally small amount is sufficient to kill a susceptible animal.

The infection is eliminated from the body in the pus and discharges from the wound. The infection is kept alive and spread, largely owing to the fact that many of the lower animals, particularly horses, are susceptible to the disease. The spores are taken with the hay, grass and other food of these animals into their intestinal canals, where they germinate and multiply in great numbers, and are passed out in the manure. In this way the soil of most inhabited localities becomes contaminated with the infection.

The disinfection of tetanus resolves itself into the destruction of the spores. In general, the degree of re-

sistance of these spores resembles those of anthrax very closely, and the methods of disinfection are the same.

Tetanus spores retain their vitality for months in the soil, in manure and in putrefying materials. A dry heat of 150 degrees, continued an hour, is necessary to kill them with certainty.

They withstand a moist temperature of 80 degrees C. for one hour, but are killed by boiling water or by steam at 100 degrees C. in a few minutes. In actual practice it is necessary to expose objects to boiling or to steam no less than two hours in order to insure perfect penetration and the destruction of the spores.

Steam under pressure is the most reliable disinfectant agent we possess for this resistant infection. An exposure of fifteen minutes to steam at a temperature of 120 degrees C. will surely kill the spores.

A 5 per cent. solution of carbolic acid requires fifteen hours to kill tetanus spores, and is therefore inapplicable as a disinfectant for the disease. Tricresol or lysol in 2 per cent. solutions may be used with an exposure of two hours.

The spores show a high degree of resistance to a 1 : 1,000 solution of bichloride of mercury. In actual practice a 1 : 500 solution should be used.

Germicidal solutions are so much more powerful when used hot that it is strongly recommended to use them at or near the boiling point.

Formaldehyde gas and sulphurous acid gas can not be depended upon to destroy tetanus spores, and are therefore totally inapplicable as disinfectants for the disease.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Actinomycosis.—A disease of man and some of the lower animals, especially cattle, horses and pigs. This affection is sometimes called big jaw, lumpy jaw and wooden tongue.

There is an intense inflammation of the tongue, the lips, cheeks, bones, lungs, skin and other tissues of the body. The cause of this disease is the ray fungus, the actinomyces. It is not known how the organism enters the system.

The sputum and the dejecta in the abdominal cases should be disinfected and bandages and other objects that have become soiled with the discharges should be burned or disinfected with steam or boiling water.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Dengue.—A communicable disease, occurring in epidemic form in the tropical regions. The disease is characterized by pain in the joints and fever, and sometimes a rash. The cause of this disease is not known. The period of incubation is from three to five days.

The disease spreads from place to place along the lines of travel. The disease is not known to be contagious although it is remarkable in attacking all the members in a community, whether they have come in contact with the sick or not. It spreads over a great expanse of territory in a short time.

It is not known how the infection leaves the body or the channels of infection, and it is not known that the dis-

ease has ever proved fatal. For this reason it is not so necessary for the embalmer to know much about the disease, as disinfection is not practiced to check the spread of this disease.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Dysentery.—Dysentery is a communicable disease, occurring in widespread epidemics with great fatality, especially in the tropics and warm climates. The disease is characteried by an inflammation of the lower bowel, accompanied with frequent and painful stools, often bloody. The symptoms of dysentery may result from one of many different poisons, but the communicable dysentery is a specific disease, due to a definite, living entity, the bacillus dysenteria, described by Shinga in 1899. It is a short, actively motile rod, closely resembling the bacillus of typhoid fever.

The bacillus of dysentery does not have spores.

It is believed that dysentery is transmitted in very much the same way as typhoid fever. The cause of the disease is taken into the intestinal tract usually with the drinking water. The milk and food may also convey the infection. As the poison is excreted from the body in the evacuation from the bowels, it is reasonable to suppose that the flies and other insects may play a part in the dissemination of the infection.

The vitality of the bacillus of dysentery is precisely similar to that of typhoid fever, and the principles of disinfection are the same, so that it is not necessary to repeat them here.

Another form of the communicable dysentery preva-

lent in the tropical and warm climates is believed to be due to a protozoon—the amoebae dysenteriae. This form of the disease is usually chronic, and, so far as known, the same methods of prevention and disinfection are applicable to it as to the above.

When a body dies of this disease and is to be shipped it should be prepared according to Rule No. 3.

Malaria.—Malaria is a communicable disease of great widespread in many parts of the world.

The disease is due to a minute animal parasite, the Haematazoa malaria, discovered by Laveran in 1880. The malarial organism is found in the blood, spleen and other organs of the body in all cases of the disease.

Malarial infections are conveyed from the sick to the well by the mosquito. The insect takes the parasite into its stomach along with the drop of blood. In the mosquito the parasite passes through a long and complicated series of changes, taking about twelve days from the time it drinks the malarial blood until it is capable of transmitting the infection by biting another person. From the stomach of the mosquito the parasite passes into the general body cavity of the insect and finally appears in the salivary glands. These glands excrete the poison that is injected through the proboscis of the insect into the skin of the person it bites, and it is in this way that the malarial parasites are inoculated into the system.

Malaria is primarily a blood infection. Not all mosquitoes are capable of transferring the infection of the malarial diseases. It is only a certain variety known as the Anopheles that is endowed with this special property. Of this variety only the female insect is capable of trans-

mitting the disease. After feeding upon blood it lays its eggs upon the surface of the water. In a few days, depending upon the temperature and other conditions, each egg hatches a larva, and this develops into a pupa. The larvae and pupae, commonly known as wigglers, must come to the surface of the water to breathe. To kill these embryonic forms a thin layer of oil is placed on the surface of the water.

It is plain, therefore, that the disinfectant for malaria must be directed against the mosquito. Patients infected with malaria must be protected with mosquito netting in order to prevent the spread of the infection. For those individuals residing in the malarial districts, a precaution would be to sleep in rooms thoroughly screened against the mosquitoes, and in this way escape infection. The mosquitoes found in the room of the sick and the well should be destroyed. For this purpose pyrethrum, sulphurous acid gas, tobacco smoke and the other insecticides mentioned in Chapter XXI, may be used. The extermination of the mosquito would mean the extermination of malaria as far as man is concerned.

It is evident that insecticides and not germicides are wanted to combat this disease.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Yellow Fever.—Yellow fever has its home in the West Indies, Central America and the west coast of Africa. From these epidemic foci in the tropics it spreads from time to time to the temperate zones, where it occurs in epidemic form, sometimes with great mortality. It is an acute febrile disease, characterized by congestion, jaun-

dice, vomiting, prostration and albumin in the urine. The vomited matter is often of a dark brown or black color, the so-called black vomit.

The period of incubation is from two to three days, rarely over five. A certain species of mosquito called the Stegomyia fasciata, after biting the patient, takes the infected blood into its stomach. The mosquito itself becomes infected, and after a lapse of twelve days can communicate the disease by biting another person. Here again, as in the case of malarial fever, the female mosquito is responsible for the spread of the disease, and in as much as the mosquito lives in the water during its early existence, as a larva, this gives us a keynote for its extermination. A thin layer of oil should be placed over all surface water, so as to kill the embryonic forms. Rooms should be carefully screened, so as to exclude the mosquito. Insecticides, and not germicides, are wanted. Wherever mosquitoes are found in the bedroom they should be killed by either burning pyrethrum, sulphurous acid gas, tobacco smoke, formaldehyde, or one of the insecticides known to be fatal to these insects.

A body dying of this disease that is to be shipped, should be prepared according to Rule No. 2 of the rules and regulations adopted by the health boards and baggage men's association.

CHAPTER VII.

DISINFECTION FOR THE COMMUNICABLE DISEASES.—Continued.

THE SLIGHTLY CONTAGIOUS DISEASES.

Diphtheria.—Diphtheria is a communicable disease, occurring in severe epidemics among the children.

It is characterized by an inflammation of the mucous membrane, especially of the throat. The character of this inflammation varies very much in degree. It may resemble the simple catarrhal inflammation resulting from "catching cold" or when more severe may cause a fibrinous deposit or false membrane, by which the disease has long been recognized clinically. Every degree of severity is met with, from the mildest type to the malignant variety that results fatally in a few hours.

Diphtheria is not confined to the throat, but may attack any of the mucous membranes of the body, including the conjunctiva. The disease may also complicate wounds, and open sores may be the seat of a typical attack of diphtheria, accompanied with false membranes and all the constitutional manifestations of the disease.

The period of incubation is from two to seven days.

The cause of diphtheria is the bacillus diphtheria, first seen by Klebs under the microscope in 1883 and isolated

in pure culture the next year by Loeffler, who proved this organism to be the cause of the disease.

The bacillus of diphtheria is a non-motile rod of variable length and very irregular shape. It is often swollen on one end, presenting a club-shaped appearance, or it may be pointed or wedge-shaped. It stains in an irregular manner with the basic aniline dyes that is quite characteristic. The bacillus of diphtheria grows well upon blood serum and artificial culture media, at the temperature of the body.

It does not have spores.

The infection may enter the body in a variety of ways. It may pass directly from mouth to mouth, or indirectly from objects that have become infected with the germs of the disease. The bacilli may be taken into the body with the food, especially milk. The infection may also be taken into the body through the respiratory system, although this is rare. The diphtheria bacillus is not found in the expired breath and the disease is not air-borne in the sense that smallpox or typhus fever is. The air may become infected from dried sputum, or from minute particles that are sprayed from the mouth in the acts of coughing, speaking, gagging, and other acts of expiration accompanied with explosive movements. The infection may also be inoculated into the wounds of the skin. When the diphtheria bacillus enters the mouth or lodges upon the mucous surfaces, it grows and multiplies, setting up local inflammation which characterizes the disease. The organism usually remains localized at the seat of the lesion, and rarely invades the deeper tissues or the blood.

During the course of its growth and multiplication the diphtheria bacillus produces a chemical poison—the diphtheria toxin. It is really this toxin ,and not the bacillus itself that causes the local inflammation and the fibrinous exudate with the death of the cells, resulting in the production of the false membrane. This toxin is a soluble poison and is readily absorbed into the system resulting in fever, prostration, and the nervous symptoms that frequently are associated with diphtheria.

The bacillus of diphtheria is eliminated from the body with the secretions from the mucous membranes, or with the pus and exudates from wounds, depending upon the seat of the local lesion. The membranes of the throat and larynx being the usual seat of the disease, the infection is most commonly thrown off from the body in the expectoration. Therefore the sputum, and all objects which come in contact with the secretions of the mouth must be carefully disinfected in order to prevent the spread of the infection.

The evacuations of the bowels and the urine do not need disinfecting in this disease.

It has been found that many persons in good health have live and virulent diphtheria bacilli in the secretions from their mouths; that is, the organism may grow upon the mucous membranes of the throat and be contained in the expectoration without causing the least inconvenience. Such persons are a constant menace to others who are more susceptible to the disease.

The infection may be spread from mouth to mouth by kissing, or indirectly, by any object that becomes contaminated with the infected secretions. Handkerchiefs, towels,

and other fabrics are especially apt to become infected and unless disinfected become sources of danger. Knives, forks, spoons, and other tableware that come in contact with the mouth may carry the infection to other persons who use such articles without previous scalding or disinfection. Toys are often responsible for the spread of the disease, on account of the habit children have of putting such toys in the mouth.

The bacillus of diphtheria grows well in milk, and epidemics of the disease have been traced to this source. The milk is usually infected at the dairy, but may be rendered safe by boiling or pasteurization.

The bacillus of diphtheria is readily killed by heat or chemicals. It is destroyed by a moist temperature of 58 degrees C. in a few minutes. Boiling water at 100 degrees C. will destroy the vitality of the infection instantly. It is to be noted that while the bacillus usually dies quickly when dried, under certain circumstances it may retain its vitality for a very long time, especially if dried in albuminous matter, such as little bits of false membrane. This accounts for the long time the infection may exist upon objects that have become contaminated with the secretions of the mouth.

The direct sunlight will kill cultures in from thirty to forty minutes.

Any of the germicidal solutions, employed in the strengths stated for the disinfection of non-spore bearing bacteria, are efficient for the bacillus of diphtheria; for example, bichloride of mercury 1:1000, carbolic acid 3 to 5 per cent., tricresol 1 per cent., formalin 3 to 5 per cent.

Formaldehyde gas kills the bacillus of diphtheria at

once, when used in the proper strength as stated on page 154, if the bacteria are exposed directly to the gas. An exposure of twenty-four hours is advisable in order to insure diffusion and penetration, for the bacilli are not always directly exposed to the action of the gas, but are encased in the mucoid and albuminous matter of the secretions.

Sulphurous acid gas is also an efficient disinfectant, but is limited in its practical application on account of its destructiveness.

Sputum should be treated as specified on page 265. Towels, bedding, linens, and other fabrics that have come in contact with the patient should be boiled, steamed, or immersed in one of the chemical solutions.

If the patient recovers from the disease, the room should have a general disinfection with one of the gases recommended, in order to destroy the infection that may have become diffused throughout the room.

If the patient dies the room disinfection should be carried out, the body thoroughly disinfected and great care should be taken to see that everything is disinfected as though the patient had lived, for the safety of others. (See Chapter XXIV).

Bodies dying of this disease which are to shipped should be prepared according to Rule No. 2 of the rules and regulations of the boards of health and baggagemen's association.

Tuberculosis.—Tuberculosis, known as the great white plague, is a communicable disease prevalent in all parts of the world.

It is caused by the tubercle bacillus, discovered by Robert Koch in 1881-1882.

The tubercle bacillus may attack almost every organ and tissue of the body. Tuberculosis of the lungs is commonly called consumption or phthisis; of the lymphatic glands it is called scrofula; of the skin it is called lupus.

The tubercle bacillus does not have spores.

It is more resistant to heat and other external influences than other bacilli. It has been kept alive in sputum three years, at the end of which time it was still virulent.

Tuberculosis is spread from person to person and from animals to man in a variety of ways. The infection may be breathed into the lungs with the dust, may be taken into the alimentary canal with the food or drink, or may be inoculated into the system through wounds of the skin or mucous membranes. When the tubercle bacillus gains entrance into the tissues, it gives rise to a characteristic form of inflammation which expresses itself in the formation of little grayish nodules, called tubercles.

The tubercle bacillus is eliminated from the body in the pus and matters discharged from the processes of destructive inflammation. As the lungs are more frequently attacked than any other organ, the infection is commonly thrown off in the expectoration. The disease is largely spread by the dried sputum which floats about the air as dust and is breathed into the respiratory tract of susceptible persons. Kissing may also spread the bacilli from mouth to mouth, and consequently no one, on no account, should ever be allowed to kiss a corpse. Tableware used by a consumptive is one of the means of con-

veying the infection to healthy persons if such ware is used without previous boiling or disinfecting.

Many of the lower animals, especially the cow, are susceptible to tuberculosis, and there is little doubt but that the disease is spread to man through the agency of infected meat and milk. Tuberculous meat is rendered safe by thorough cooking, and milk is rendered safe by the well-known process, called pasteurization, which consists of heating it to 70 degrees C. for half an hour and then chilling it suddenly.

The tubercle bacillus may be killed by boiling water or steam at a temperature of 100 degrees C. Drying has little effect on the bacillus, which accounts for the dangerous nature of dried sputum. It is not killed by freezing. The bright sunshine will kill the organism in a few hours, if it is exposed directly to the rays of the sun and provided the sputum is not too thick. The chemical solutions in the strength given for non-spore bearing bacteria are efficient disinfectants for the bacillus of tuberculosis, provided there is direct contact between the germ and the chemical solution; for example, bichloride of mercury 1 : 1000, carbolic acid 5 per cent., tricresol 1 per cent., formalin 5 per cent., lysol 2 per cent.

When the germs are embedded in the sputum, disinfection will be found comparatively difficult on account of the albuminous nature of the sputum. For sputum, bichloride of mercury is totally inapplicable, because it is precipitated by the albuminous matter which it coagulates, preventing penetration. Carbolic acid also coagulates albuminous matter, though less actively than bichloride of mercury, and is therefore a very untrustwor-

thy agent for the disinfection of sputum. A strong solution of formalin 15 to 20 per cent., or tricresol 2 per cent., or lysol 2 per cent., may be used to disinfect small quantities of sputum, provided they are thoroughly incorporated throughout the mass and allowed to stand no less than one hour. The best way to effectively dispose of sputum is by burning.

For fumigation purposes, either formaldehyde or sulphurous acid gas will kill this bacillus in the strengths stated in Chapter XV. An exposure of no less than twelve hours to formaldehyde and twenty-four hours to sulphurous acid gas is desirable.

The disinfection of fabrics and other objects that have become contaminated with the tubercle bacilli does not differ from the methods given for the disinfection of such materials for other non-spore bearing infections, such as typhoid fever, diphtheria, pneumonia, etc., and need not be repeated here.

When a body dies of this disease and is to be shipped it should be prepared according to Rule No. 3.

Typhoid Fever.—Typhoid, or enteric fever, is a wide-spread communicable disease, frequently occurring in severe epidemics.

The symptoms of the disease are very inconstant. A typical case is marked by a continued fever lasting about four weeks, a rose colored eruption, diarrhea, abdominal tenderness, tympanites, and enlargement of the spleen.

The period of incubation is variously stated from eight to fourteen days, sometimes twenty-three.

The cause of typhoid fever is a short, actively motile rod called the bacillus typhosis, sometimes called the

Eberth bacillus, in honor of its discoverer, who described the organism in 1880.

The bacillus of typhoid fever does not have spores.

The organism is taken into the mouth, passes into the intestinal canal, where under favorable conditions it grows and multiplies, invading the system, giving rise to the lesions and the symptoms of the disease. A catarrhal condition exists throughout the small and large intestines, and the lymph follicles become swollen, hyperplastic, and may ulcerate. The bacillus is readily found in the inflamed lymphoid tissue, also in the rose-colored eruption, the enlarged spleen, and mesenteric glands. The bacillus frequently invades the blood, and may be found widely disseminated throughout the organs and tissues of the body.

The typhoid bacillus produces a soluble poison in the course of its growth, called typho-toxin. It is this poison which is largely responsible for the fever, the inflammation of the lymphoid elements of the body, the effect upon the heart and nerves, and the more serious features of the disease.

The bacillus of typhoid fever is eliminated from the body in the stools, the urine, and sometimes in the sputum, so that practically all the discharges from the body may contain the infective agent and must be disinfected in order to prevent the spread of the disease.

The discharges from the patient contaminate the water, the milk, and the food supply. It is largely in this way that the disease is spread from the sick to the sound. Typhoid fever may be communicated through the medium of articles of diet other than the water and the

milk. For instance, green vegetables, such as salads, radishes, celery and the like, that are eaten without previous cooking, may be contaminated with infected water or soil that has been fertilized with the human manure. Raw oysters have also been known to set up several small epidemics of the disease.

There is little evidence to show that typhoid fever is air-borne, or that the infection is, as a rule, taken into the system in any other way than by the mouth. This is a very important fact in applying our disinfecting agents for the suppression of the infection. It is true that pulmonary forms of the disease without intestinal lesions have been reported, but such instances seem to be exceptional.

Flies are responsible for much of the spread of typhoid fever. They breed in and feed upon the dejecta and the infected discharges, thereby conveying the infection directly to the food-supply. It is easy to understand how flies, and other insects with similar habits, carry the typhoid bacilli smeared upon their feet and bodies, as well as in their intestinal contents, thereby contaminating the meat, the butter, and other foods, especially the milk, in which this organism grows so well. A can of milk contaminated with a few typhoid bacilli may, in a few hours, at ordinary temperature, be teeming with the infection, without producing any apparent change in the milk.

Flies, by alighting upon our lips or other portions of our body, may be the means of introducing the infection more directly into our mouths. The importance which flies play in spreading the infection of typhoid fever is not realized. This factor must always be taken into ac-

count in applying our disinfectants and other means to limit the spread of the infection.

The typhoid bacillus is a hardy organism. It is found in the water, the soil, the air, the dust, sewage and in the milk, as well as upon solid clothing, etc., contaminated directly or indirectly by the discharges of the sick. It finds abundant conditions in nature for its growth and development and enjoys the power of accommodating itself more readily to environment than the majority of the pathogenic bacteria. For instance, the addition of from 0.1 to 0.2 per cent. of carbolic acid to the culture media does not retard its growth and development. It may retain its vitality for three months in distilled water, which indicates what a minute amount of organic matter is necessary for the life of the typhoid bacillus.

A moist temperature of 60 degrees C. will kill the bacillus of typhoid fever in ten minutes, and boiling water or steam at a temperature of 100 degrees C. will destroy the vitality of the bacillus at once. It usually dies quickly when dried, although it has been kept alive several months on fabrics. It is apparently not affected by freezing. It soon dies when exposed to the bright, direct rays of the sun.

Formaldehyde and sulphurous acid gas will kill this bacillus in the strengths and times stated for the employment of these gases.

All the ordinary germicidal solutions in the strengths given for the destruction of non-spore-bearing bacteria are efficient disinfectants for the typhoid bacillus: for example, bichloride of mercury 1:1000, carbolic acid 3 to 5 per cent., formalin 3 to 5 per cent., tricresol 1 per cent., etc.

The disinfection for typhoid fever begins with the destruction of the infection in the discharges as they leave the body, before they have a chance to contaminate the surroundings, the water or food supply.

The evacuation from the bowels should be received in a vessel containing a 5 per cent. solution of carbolic acid, 2 per cent. tricresol, or 5 per cent. formalin. More of the solution must be added afterward so that it is present in equal volume and thoroughly incorporated throughout the mass. The mixture should stand one hour before it is disposed of. Bichloride of mercury is not suitable for the destruction of the infection in the dejecta on account of its property of coagulating and combining with the albuminous matter, which prevents its penetration. Lime and its various compounds are cheap and efficient disinfectants for this purpose and the methods for their use are given on page 181.

The urine frequently contains the infective agent of the disease and is usually disinfected with the evacuations from the bowels. If passed separately it may be disinfected by adding sufficient bichloride of mercury to make a 1:1000 solution, or carbolic acid 3 to 5 per cent., tricresol 1 per cent., or formalin 3 to 5 per cent., and allowed to stand one hour before it is discarded.

The sputum will also need treatment as it frequently contains the typhoid bacillus. The proper methods of disinfecting the sputum have been given upon page 265 and need not be repeated here.

All materials that have become contaminated from a case of typhoid fever must be disinfected by appropriate methods. This applies especially to the towels, bedding,

and other fabrics used about the case. As boiling water or steam destroys the vitality of the typhoid bacillus instantly, either of these methods is particularly applicable to the disinfection of objects of this class. If the bedding is not soiled it may be immediately boiled, otherwise it must be treated so as to take out the albuminous materials in order to prevent indelible staining, resulting from the coagulation and fixing of these materials in the fabric.

The bedding and fabrics contaminated with the infection of typhoid fever may also be disinfected by immersion in one of the germicidal solutions mentioned above.

The bedding should be changed frequently and everything about the sick-room kept clean and fresh. The room should be well ventilated and the floor and surfaces kept clean and fresh and free from infection by frequent mopping with a 1:1000 bichloride solution. The patient himself will need scrupulous attention and careful nursing in order to keep his skin clean. The mouth and lips need frequent washing with listerine, boracic acid, or other mild antiseptic solutions. The buttocks must be cleansed and washed with a 1 : 1000 bichloride solution, and the rags used for this purpose had best be burned.

The food may be disinfected by thorough cooking and the milk by boiling or pasteurization, which consists in heating the milk to a temperature of 70 degrees C. for half an hour and then chilling it suddenly. After the food and milk have been disinfected it is important to guard against their recontamination, by contact with infected water or by flies.

The spoons, cups, and other tableware should be scalded before being used again, and the remnants of food

remaining from the patient's meal should be burned or boiled before being thrown out.

The hands of the nurse and others who come in contact with the patient or his discharges must be very carefully disinfected by immersing them in one of the germicidal solutions (see page 262). This procedure is important from a general standpoint of preventing the spread of the disease, but is doubly important on the farm or dairy, where the same hands that nurse the sick or handle the dejecta afterward milk the cows.

The sick-room should be carefully screened to prevent the annoyance as well as the danger of flies. Any insects found in the room should be caught and burned.

In cases where the above precautions have been intelligently carried out there is no reason to fear the spread of the infection, and it is not necessary to practice a general disinfection with one of the gases. In fact, both formaldehyde gas and sulphurous acid gas are of little practical use in combating an infection that is taken into the body through the alimentary canal and not the respiratory system. In other words, it is more important to boil the drinking water, and to thoroughly cook the food, and to pasteurize the milk, and to protect against the infection carried by flies, than to attempt to destroy with one of the gases the typhoid bacilli that may contaminate the surfaces of exposed objects.

Bodies dying of this disease that are to be shipped should be prepared according to Rule No. 2 of the rules and regulations of the boards of health and baggagemen's association.

Leprosy.—Leprosy is a communicable disease, transmitted from the sick to the well with difficulty. It is a disease of great antiquity and at the present time is widely distributed through the world, especially in the warm climates.

The disease is caused by the bacillus leprae, discovered by Hansen in 1879. So far as is known it does not have spores.

The disease may be transmitted from the sick to the well by inoculation into the skin or mucous membranes, the material containing the bacillus. The organism is found in great numbers in the pus and secretions from the broken down nodules and ulcers of the disease and in all the lesions of leprosy. They may also be found in the blood. As the nodules and ulcers frequently appear upon the mucous membranes of the nasal cavity, the secretions from the nose may be infective.

So far as known, the principles of disinfection for leprosy are precisely the same as for tuberculosis.

If a body dies of this disease and it is to be shipped, it should be prepared according to Rule No. 2 of the rules and regulations of the boards of health and baggagemen's association.

Pneumonia.—Pneumonia is one of the most widely spread of the communicable diseases. It sometimes occurs in severe epidemics and with great mortality. The cause of pneumonia is the diplococcus pneumoniae. This organism does not produce spores. The infection of pneumonia is probably always taken into the system through the respiratory channels.

The infection is thrown off with the sputum, which during the course of the disease is laden with great numbers of the live and virulent germs. The infection may be eliminated in other secretions and discharges, depending upon the seat of the lesion. The infection is spread from mouth to mouth, directly or indirectly, in a great variety of ways, just as the infection of diphtheria and tuberculosis is spread.

The diplococcus of pneumonia does not show a high grade of resistance to external influences and may readily be destroyed by the germicidal agents commonly employed against non-spore bearing infections. The germ when embedded in a mass of sputum is more virulent. A moist temperature of 52 degrees C. continued ten minutes, is fatal to the germ. Boiling water or steam destroys the infection at once. Fumigation with formaldehyde or sulphurous acid gas are efficient when employed in the strengths and the times stated for each of these gases. (See Chapter XV). Bichloride of mercury 1:000, carbolic acid 3 to 5 per cent., tricresol 1 per cent., formalin 3 to 5 per cent., are useful liquid disinfectants. Solutions of bichloride of mercury are not to be used for the disinfection of sputum, because it is precipitated by, and cannot penetrate the albuminous matter.

In general the principles of disinfection are the same as for diphtheria and tuberculosis.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Influenza.—Influenza is a communicable disease occurring in wide spread epidemics. It is also called "La Grippe." It spreads with greater rapidity than any

known infection, for in a few weeks a whole continent may be involved.

The period of incubation is from one to four days.

The cause of this disease is the bacillus influenzae. It does not have spores.

The disease is contagious in the sense that it is communicable by contact between the sick and the well. The bacillus is found in great numbers in the secretions from the mouth and the nose of those suffering from the disease, and the infection is chiefly eliminated through these channels. The bacillus is not found in the blood.

Formaldehyde and sulphurous acid gas are trustworthy disinfectants, in the strengths and times stated for the employment of these gases. The chemical solutions in their ordinary strengths, as employed for the non-spore bearing infections, will kill the bacillus of influenza. The disinfection for influenza will be about the same as that recommended for diphtheria and tuberculosis, especially as the infection is largely thrown off from the body in the expectorated matter. The handkerchiefs, towels, bedding and other fabrics, that have come in contact with the infection should be boiled, steamed or immersed in one of the germicidal solutions. The room in which the patient has been, should be well fumigated and disinfected.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Cholera.—Cholera is a communicable disease native to India, where it is always present, sometimes existing in widespread and very fatal epidemics. From time to time it is transported along the lines of travel and commerce

to all parts of the world. Many severe epidemics have been caused in seaport towns by the introduction of a few cases on a vessel. Cholera is often called Asiatic cholera on account of its home in India, to distinguish it from cholera nostras, cholera morbus, and other forms of non-communicable affections with choleric symptoms.

A typical case of cholera is characterized by violent purging, cramps, rice-water discharges, and rapid collapse.

The period of incubation varies from a few hours to five days.

The disease is due to the "comma bacillus" discovered by Koch in 1883-1884. This microorganisms is curved or spiral-shaped and is therefore now called the spirillum cholerae Asiaticae. It is actively motile, and grows very well on alkaline media containing the slightest trace of albuminous matter, at ordinary temperatures as well as at the temperature of the body.

The spirillum of cholera does not have spores.

In the body the infection is confined to the alimentary tract. The cholera spirillum is practically always introduced into the system in the drinking water or with the food. It may also be introduced into the mouth by means of the hands or other objects that have become soiled with the infection. Of all the diseases of man that occur in epidemic form cholera is the type of the water-borne infections. There can no longer be any doubt but that the great outbreaks of this disease in large communities are always due to the contamination of the drinking water. The spirillum of cholera grows well in milk, and will keep alive and virulent a long time in moist albuminous food-

stuffs, so that articles of food may spread the infection as well as the water. Vegetables and fruits are apt to become infected with the polluted water or from other sources, and if eaten raw may cause the disease. The flies play a similar role in spreading the infection of cholera that they do in typhoid fever.

After the cholera spirillum passes the acid juices of the stomach, it grows and multiplies in such enormous numbers in the intestines that every drop of the mucous discharges from the intestines may contain myriads of the organisms. During the course of its growth and multiplication it produces a poison or toxin which gives rise to the diarrhea, vomiting, cramps and prostration which characterize the disease. The spirillum of cholera remains confined to the intestinal canal. It does not invade the blood, and is therefore only eliminated from the body in the matters passed from the bowels, and sometimes in the vomit.

The cholera spirillum is somewhat less resistant to external influences than the typhoid bacillus, and the same agents used for the destruction of the typhoid bacillus may be used for the destruction of the infection of cholera.

A moist heat of 65 degrees C. will kill the spirillum of cholera in five minutes. Boiling water or steam at 100 degrees C. kills the infection almost instantly. Most authorities agree that it dies quickly when dried, usually in from three to four hours. In a moist condition it retains its vitality for months, especially in the presence of organic matter, but it soon loses its virulence. The sunlight is also quickly fatal.

The organism may live a long time in water, as may well be imagined from the fact that the disease is water-

borne. In fact, it has been shown that if placed in sterilized water this organism grows with great rapidity and can be found alive after months have passed.

Formaldehyde and sulphurous acid gas kill the spirillum in the strengths and times stated for the employment of these gases.

All the ordinary germicidal solutions used in the strengths given for the destruction of non-spore-bearing bacteria, are efficient disinfectants for the cholera spirillum. For example, bichloride of mercury 1:1000, carbolic acid 3 to 5 per cent., tricresol 1 per cent., formalin 3 to 5 per cent., etc.

The disinfection of cholera begins at the bedside. In general, the measures and methods described to prevent the dissemination of the infection of typhoid fever are applicable to cholera, and need not be repeated in detail.

Most important is the destruction of the infection in the stools and in the vomited matter. For this purpose use formalin 5 per cent., carbolic acid 5 per cent., tricresol 2 per cent., or lime, and thoroughly incorporate the disinfectant throughout the mass and allow it to remain covered one hour. The above substances are considered the most trustworthy for the disinfection of these materials in small amounts, but in their absence other germicides mentioned in the article on excreta (page256) may be used. Bichloride of mercury is not applicable for this purpose, on account of its lack of penetration in the presence of albuminous matter.

All the bedding, body linen, towels, and other fabrics that have in any way come in contact with the patient or

his discharges should be immediately boiled, steamed or immersed in one of the disinfecting solutions. The hands of the nurse and the body of the patient must also be kept clean and free from infection by frequent use of one of the disinfectants applicable to this particular purpose.

The excreta and all objects that have become contaminated must be disinfected at once, or, if this is not possible, they must be carefully protected from the flies and other insects.

When cholera prevails or is present in the epidemic form, it is essential to boil all the drinking water and thoroughly cook all the food. More than this, it is important not to eat or drink out of cups or plates that have been washed with the infected water. All the table ware must be scalded, and the milk boiled or pasteurized, and no green vegetables, such as salad, radishes, celery, and the like, partaken of unless first treated with tartaric acid and washed as prescribed on page 259.

There is no need to practice disinfection with one of the gases after a case of cholera, where the above precautions have been carried out. If through ignorance or neglect the infection has contaminated the room and its contents, a general disinfection may be done with formaldehyde gas or sulphurous acid gas, according to the methods described for applying these agents for nonspore bearing infections.

So well do we know the habitat of the cholera spirillum in nature, as well as its channels of introduction into and discharge from the body, that we can supply our germicidal agents with great accuracy and with every assurance of destroying the infection and limiting the

spread of the disease; in fact, our methods have reached such a satisfactory state, that it is possible to live in the midst of a raging cholera epidemic without contracting the disease.

A body dying of this disease, and is to be shipped, should be treated according to Rule No. 2 of the rules and regulations adopted by the health boards and baggagemen's association.

Plague.—Plague,also called bubonic plague, la peste, black death, and other names, is a communicable disease occurring in widespread and very fatal epidemics in man and some of the lower animals. Of all the epidemic diseases, plague has caused more deaths in a shorter time than any pestilence known to man. In the thirteenth century, about a quarter of the people living in Europe died of this affection in a few years.

The period of incubation is from three to five days, rarely over seven.

The cause of plague is a short rod, called bacillus pestis. It grows well if kept at the body temperature, 37 degrees C. It was discovered by Yersin in 1894, in the epidemic which was then raging in Hongkong. The plague bacillus in its growth, produces a poison, plague toxin, which is absorbed by the system, causing the fever, prostration and nervous depression, which characterizes all forms of the disease. When the bacillus enters the body through a wound in the skin, it causes a local inflammation which quickly spreads through the lymphatic channels to the neighboring lymph glands. These become swollen and painful, and are known as buboes—hence the name of bubonic plague. When the

infection is taken into the respiratory tract, the inflammation in the lungs resembles very closely that of lobar pneumonia. When the bacillus is taken with food or drink into the alimentary canal, it may cause a sore throat, tonsils, or inflammation of the intestines.

The bacillus of plague may be eliminated from the body in any of the discharges—that is, in the expectorated matter, the pus discharged from the buboes, discharges from blisters, abscesses or carbuncles associated with the disease, or in the alvine discharges. It will, therefore, be seen that practically all the discharges from the body must be disinfected in order to prevent the spread of the disease.

Animals, such as rats, mice, cats, dogs, cattle and other domestic animals are susceptible to the disease. It is believed that the flea is responsible for carrying the infection from rat to man. Ants and flies which have fed on infected material may deposit virulent bacilli through their excretions, in food, in drinkables, especially the milk, on the floors, tables, etc., and on the body and clothing of persons. These insects do not inoculate the disease germ into the system when they bite, as it is more probable that the irritation caused by the bites induces the individual to scratch or rub the infection into the skin.

The plague bacillus is not a frail organism. In the presence of moist or albuminous matter it may keep alive and virulent for a very long time. It, however, dies quickly when dried. Moisture favors its life. Sunlight kills the organism in a few hours, providing the temperature in the sun is above 30 degrees C. Boiling

water or steam at a temperature of 100 degrees C. kills the organism at once. The usual germicidal solutions are all efficient against plague in the strength in which they are ordinarily used for the destruction of non-spore bearing infections; for example, bichloride of mercury 1:1000, carbolic acid 3 to 5 per cent., tricresol 1 per cent., formalin 3 to 5 per cent.

The plague bacillus is destroyed by fumigation with sulphur and formaldehyde gas in the strength in which these disinfectants are used (see Chapter XV). Formaldehyde gas has very little effect on the higher forms of life, and as plague is a disease which is very largely spread through the agency of fleas, flies, rats, and other rodents, it is essential to use a disinfectant that will destroy vermin of this character as well as the plague bacillus itself. Sulphurous acid gas, chlorine gas and hydrocyanic acid gas are agents of this class, and they should be reviewed (see Chapter XV).

Disinfection at the bedside of a case of plague should be rigorously carried out as a daily routine. All sputum, dejecta, urine, blood, pus, serum of the blisters, pus from the buboes, contain the infective material and must be destroyed.

Bodies dying of this disease should not be shipped from one state, territory, district or province to another.

CHAPTER VIII.

DISINFECTION FOR THE COMMUNICABLE DISEASES.

THE VERY CONTAGIOUS DISEASES.

Scarlet Fever.—Scarlet fever is a communicable disease occurring in epidemics among children. The disease is characterized by a sore throat, a diffuse eruption and desquamation of the epidermis.

The pathogenic microbe of scarlet fever, according to Klein and Gordon, is the streptococcus scarlatinae or conglomeratus, which they have isolated from the blood and nasal and tonsilar discharges of persons suffering from the disease. These observers have grown the streptococcus in broth, gelatine, agar, milk, and blood serum, in several of which media it gives a characteristic culture.

The incubation period is from three to four days.

The disease is communicated directly from the sick to the well, probably through the agency of the fine scaly eruptions which are diffused with the dust throughout the room. The infection clings with great persistence to clothing of all kinds, and to articles of furniture and other objects in the room. Bedding and clothing that have been put away for months and even for years may, unless thoroughly disinfected, convey the

infection. Physicians, nurses and the embalmer may carry the infection to persons at a distance.

Epidemics of scarlet fever have also been traced to the milk, and there is little doubt but that this fluid may be responsible for the spread of the disease.

As far as the disinfection of scarlet fever is concerned, we must be guided by experience, and as a rule the same principles are applied as for smallpox.

A body dying of this disease that is to be shipped should be prepared according to Rule No. 2 of the rules and regulations of the boards of health and baggagemen's association.

Smallpox.—Smallpox is a communicable disease, the cause of which is not known. The incubation period is from twelve to fourteen days.

Smallpox has long been considered a contagious disease, because it is more readily conveyed by contact between the sick and the well than any other of the communicable diseases of man. We know that the specific virus is thrown off from the patient into the surrounding air, perhaps with the exhaled air, and certainly from the eruption, whether fluid or dried in the crusts. It is probable, though not proven, that the virus is contained in the blood, but not in the excreta.

It is believed that the virus enters the system through the respiratory tract. It is definitely known that inanimate objects which have come in contact with the patient or the infectious discharges may retain the infection alive and virulent, and communicate the disease to others even after the lapse of a very long time. For example, blankets, bedding and clothing which have been used by

the patient, and afterward packed away without any disinfection, have caused the disease in other persons who have unpacked or handled these articles months afterward.

Although the cause is not known, fortunately we do know the disinfectant agents and their strengths necessary to kill the infectious principle, whatever it may be. So certain has our knowledge become that only wilful negligence or ignorance will permit smallpox to become epidemic in a community. In short, isolation of the sick, vaccination and disinfection will certainly prevent the spread of the disease.

The disinfection for smallpox must begin at the bedside. It is important to keep the skin of the patient well anointed with an oil or salve, to prevent the scaly eruptions and the dried secretions of the eruptions from floating in the air. The sputum may become contaminated, and should be disinfected. The urine and the feces, although not believed to contain the virus, may also become contaminated and should be disinfected by methods given for these substances. (See pages 256-267). The doctor in charge should see that the sick-room contains only the necessary articles, and all carpets, hangings, upholstered furniture and other objects not necessary for the care and comfort of the patient should be removed. The windows should be screened to prevent the ingress and egress of flies and other insects, for it is reasonable to suppose that flies which come in contact with the eruption may convey the infection smeared on their feet and their bodies, to persons in other rooms of the same house or other houses. It is well to keep a sheet wet with a solu-

tion of bichloride of mercury hanging in the doorway leading from the sick chamber, and to restrict the communication with the sick-room as much as possible.

Treatment by the Embalmer.—Wash the body with a disinfecting solution, bichloride of mercury 1:1000, or carbolic acid 5 per cent., or the formaldehyde embalming fluid you are using. Wash out the mouth, nasal orifices, eyes, ears, and plug all the orifices of the body with cotton saturated with a disinfectant solution. Give a thorough arterial injection, injecting sufficient fluid so that the skin becomes firm. If the body is to be transported, which can be done under the rules of certain states, the treatment should be the same as for all other contagious diseases, that is, the thorough washing of the body with a disinfecting solution, thorough arterial and cavity embalming, wrapping the body in a dry layer of cotton at least one inch thick, and wrap in a dry sheet, and comply with the rules of the state board of health.

The disinfection of the room and its contents may best be accomplished by one of the gases, either formaldehyde or sulphur. These gases, though, cannot be depended upon for more than a surface disinfection; therefore carpets, hangings, clothing, bedding, upholstered furniture and other objects needing deeper penetration to disinfect them, must be removed for other treatment appropriate for each object, as has been described elsewhere. The preparation of the room for the fumigation should be carefully arranged, as described in Chapter XXIV.

It is well for the embalmer and the fumigator in these cases to protect themselves and prevent spreading the

disease by wearing the regulation disinfection suit. After the work is completed, the suit can be placed in a canvas bag and afterward disinfected separately.

The former rules of the State Board of Health prohibited the transportation of bodies of persons dead of smallpox. The amended rules as adopted November 21, 1912, permit the transportation of bodies dead of smallpox provided: "The body shall be thoroughly embalmed with an approved disinfectant fluid, all orifices shall be closed with absorbent cotton, the body shall be washed with the disinfectant fluid and enveloped in a sheet saturated with the same and placed at once in the coffin or casket which shall be immediately closed, and the coffin or casket or the outside case containing same shall be metal or metal lined and hermetically and permanently sealed." Many states have adopted this ruling.

Measles.—Measles is an epidemic communicable disease. There is a fever, catarrhal symptoms, especially of the mucous membranes of the respiratory tract, and a rapidly spreading eruption with desquamation of the epidermis.

The period of incubation is about ten days.

The cause of measles is not known, but it is probable that the infectious agent is thrown off in the breath of the affected person. The disease is communicated by the secretions, particularly that of the nose, and there is no doubt but that the desquamating epidermis may also transmit the infection. So far as the methods and channels of infection are concerned, this disease resembles smallpox. The infection may also be transmitted through a third person or by fromites—that is, inanimate things.

The disinfection for measles is the same as for small-pox, and need not be repeated here.

Points to remember.

(1) That it is an acute contagious disease.

(2) That it is highly contagious, and affects most children.

(3 That it rarely occurs more than once in one's life-time.

(4) That its infecting agent is not known, only that it is classed with the diseases caused by protozoa.

(5) That males are more susceptible than females.

(6) That the mortality is light, death mostly occurring from complications.

(7) That the strictest sanitary measures should be carried out in the treatment of it.

When a body dies of this disease and is to be shipped, it should be prepared according to Rule No. 3.

Mumps.—Mumps, sometimes called epidemic parotiditis, is a communicable disease, often occurring in the epidemic form. It is an inflammation of the parotid gland.

The cause of mumps is the tetrad of mumps.

The period of incubation is from two to three weeks.

How the disease is communicated from the sick to the well has not as yet been determined, but is supposed that the saliva contains the infective principle, and therefore handkerchiefs and other fabrics and objects which come in contact with the secretions of the mouth should be disinfected.

When a body dies of this disease, and is to be shipped, it should be prepared according to Rule No. 3.

Chicken-pox.—Chicken-pox is an acute communicable disease, frequently occurring in epidemics among children. The disease has no relation to smallpox.

The cause of the disease is not known.

The period of incubation is from ten to fifteen days.

The disease is highly contagious in the same sense that smallpox is—that is, by contact between the sick and the well.

As far as disinfection is concerned, precisely the same methods and agents recommended for smallpox are applicable to this disease.

When a body dies of this disease, and is to be shipped, it should be prepared according to Rule No. 3.

Whooping-cough.—Whooping-cough is a communicable disease, sometimes epidemic, especially in young children.

The cause of whooping-cough is not known.

The period of incubation is from two to ten days.

The disease is communicated directly from the sick to the well through the secretions of the mouth and the respiratory tract. The virus is also believed to be harbored in handkerchiefs, towels, clothing, bedding, and upon furniture and objects in the room, and thus be able to transmit the disease.

So little is known as to the cause of this disease and the method of its spread, that we have no accurate scientific data upon which to base our disinfection.

All handkerchiefs, towels, eating utensils and other objects that come in contact with the secretions of the mouth, should be boiled or steamed. The room in which

the patient is isolated should be well disinfected and fumigated.

When a body dies of this disease, and is to be shipped, it should be prepared according to Rule No. 3.

Typhus Fever.—This is a highly communicable disease, formerly occurring in very severe epidemics. It now is a very rare disease because of sanitary measures. It is sometimes called spotted fever, jail fever, camp fever, hospital fever. It spreads in filthy, overcrowded and unsanitary places. This disease in former years claimed many victims in Europe and in this country, but since modern improvements in sanitation have been introduced into cities and institutions, and the misery of poverty has been diminished, there seems to be no tendency for the disease to spread, although it is always present in some of the larger cities.

Typhus fever is acute, specific, a febrile disease, characterized by sudden onset, severe depression, and a rash. The fever usually terminates by crisis about the end of the second week.

The cause of the disease is unknown. The period of incubation is about twelve days. The disease is believed to be contagious in the sense that it is communicated by contact between the sick and the well. When the disease exists in the epidemic form, it is the most highly contagious of all the diseases of man. The nurses, physicians, and those who come in contact with the patient are the first to take the disease. Once an epidemic, few escape. The infection seems to be given off into the atmosphere surrounding the patient, although at the present time nothing is known definitely as to the way the infection

may leave the body or the channels of infection. It is evident that sanitation is needed to prevent the disease, where it prevails, and consequently not much disinfection is required.

When a body dies of this disease, and is to be shipped, it should be prepared according to Rule No. 3, unless more stringent requirements are enacted.

PART III.

PROPHYLAXIS IN GENERAL AGAINST DISEASE.

CHAPTER. IX.

VITAL PROCESSES.

After having studied the causation of disease, the modes of dissemination and spread of special diseases, a still more important part remains—that of the prophylaxis in general against disease.

Prophylaxis means the prevention of disease, and it is found that disease to a certain extent can be prevented by vital processes and by some special processes.

Immunity.—Immunity may be said to be that condition which exists in an animal that enables him to resist the entrance of disease-producing germs, or when the germs gain entrance to the body, their growth and development are prohibited. Or, immunity may be said to be that condition existing in the body which will keep one from taking a disease.

Susceptibility is that condition directly opposite immunity. Instead of resisting the entrance or growth of disease germs in the animal body, a passive inertia exists which permits the pathogenic bacteria to develop without opposition. Or, susceptibility is a certain condition existing in the body that will render the person liable to take a certain disease.

Immunity is only a relative term; all living organisms, at least all the higher forms, are susceptible under certain conditions, to some kind of parasitic invasion. On the

other hand, some degree of resistance against parasitic attack seems to be manifested by all animals and plants. In some cases the defense is so effective that bacteria and other parasitic microorganisms rarely invade the body under natural conditions. The wild carnivora, for example, are probably exempt from bacterial infections. The cat and the dog, as is well known in bacteriological laboratories, show, as a rule, a high degree of resistance to inoculation with bacteria that are highly pathogenic for other animals. In other cases infection occurs more readily. Man is susceptible to infection with a great variety of microorganisms, certain of which possess little or no pathogenic power for any other animal. Resistance to bacterial infection is often naturally inborn of race or individual. Such resistance is termed natural immunity and is the converse of natural susceptibility.

A state of natural susceptibility may be transformed by various causes into a condition of greater or less resistance, commonly designated as acquired immunity.

Most civilized men are born with natural susceptibility to smallpox, but acquire immunity during their invidual lifetime by vaccination or by an attack of the disease.

Immunity is divided into natural and acquired immunity.

Natural Immunity.—By this term is meant the natural and constant resistance which certain healthy animals exhibit toward bacterial infection. Natural immunity may be said to be a condition which is transmitted from parent to offspring. Natural immunity depends upon the simple fact that a microorganism which finds favorable

conditions for multiplication in one species of animal meets with unsuitable conditions in another species.

The metabolic differences, such as those between warm-blooded and cold-blooded animals, are in themselves sufficient to account for much so-called natural immunity.

Closely related races and species of animals sometimes display, one a natural immunity, another a natural susceptibility to the same infecting agent.

Members of the same family, exposed at the same time to the same possibility of infection, show greatly varying susceptibilities.

Acquired Immunity.—Acquired immunity is a condition which is brought about by accidental circumstances. It is an immunity established in one's own lifetime. Acquired immunity is divided into active and passive immunity.

(a) *Active acquired* immunity is a condition existing in the body, the result of the body having actually gone through the disease in one form or another. Active acquired immunity depends upon a specific reaction on the part of the cells and tissues of the individual organism. Such immunity is gained at the expense and often at the risk of the one acquiring it. An example of active acquired immunity is smallpox. The immunity may be obtained either by an attack of the disease due to natural exposure, or by the now common method of vaccination with cow-pox virus.

Active acquired immunity once established as the result of natural exposure will last a lifetime, or as in the case of vaccination, the body actually suffers from the disease, but in a milder form, without the patient know-

ing of it or causing him any inconvenience. Immunity from vaccination is established for a period of from seven to eight years.

(b) *Passive acquired* immunity is a condition existing in the body, the result of having received into that body antitoxic substances formed in the body of another. The body does not actually go through the disease, but only has antitoxic properties injected into it, and as a result passive immunity is established. Passive immunity may be quickly acquired, but it is also much less permanent than active immunity and tends to quickly disappear.

An example of this type of immunity would be the preventive treatment for diphtheria, gonorrhea and tetanus, where the administration of the different antitoxins bring about a passive immunity,

CHAPTER X.

SPECIAL PROCESSES.

Disinfection.—Disease may also in a measure be prevented by disinfection, fumigation, sterilization, and by a strict observance of the laws of hygiene and sanitary science in general.

The term disinfection, strictly speaking, signifies the destruction of infectious agents, including microorganisms and any material that may contain infection. In general use, however, disinfection is applied more particularly to the destruction of living microorganisms, hence the terms disinfectant and germicide have become synonymous by usage. Owing to misunderstanding the meanings of terms in this connection, it seems necessary to give some definitions in order to prevent the confusion that arises from their indiscriminate and inaccurate use.

A disinfectant or germicide may be defined as a substance that kills bacteria and their spores.

An antiseptic is a substance that is antagonistic to or prevents the growth of bacteria, without necessarily killing them.

A deodorizer may be either a disinfectant or an antiseptic, or neither, but simply a substance having the power of destroying or masking odor, without regard to either destruction of the microorganisms that cause it or the arrest of their development. Deodorants

are divided into two classes, after the manner in which they destroy or mask the odor. *A true deodorant is one that acts chemically with the cause of the odor, and thus forever puts a stop to the obnoxious gases originating from that source.* An example of a true deodorant would be formaldehyde, and to understand how formaldehyde acts as a true deodorant, we must understand the nature and cause of putrefaction. (See page 35). Putrefaction is the result of living saprophytic microorganisms trying to satisfy their own nutrition, and as a result of this, produce waste products in the form of gases which are unpleasant to the smell. Now, inasmuch as the obnoxious gases are the result of bacterial work, a deodorizer, to be a true one, must retard or kill these living bacteria. Formaldehyde, when injected into the human body in the proper quantities and strengths, acts in this way, and is therefore a true deodorant.

A false deodorant is one that, having a more pleasant and characteristic odor of its own, merely covers up the obnoxious odors superficially by masking them. An example of a false deodorant would be any perfume. The perfume is either placed superficially on the body or sprayed about the body or room, and in this way the obnoxious odor is covered up. But a false deodorant can in no way be permanent, for when its characteristic odor wears away the obnoxious odor will again prevail, since the cause of the odor was not actually destroyed. The sweet smelling flowers would also be an example of a false deodorant. But few if any of the trustworthy disinfectants possess the power of completely destroying bad odors. In order to destroy a bad odor

it is best to use a sufficient amount of an antiseptic to prevent decomposition and putrefaction, hence if we prevent decomposition, we prevent the generation of gases which emit bad odors.

Disinfection may be brought about in a great many ways. The name applied will depend upon the agent used.

Fumigation is that form of disinfection where the agent used is a gas having disinfectant properties. Sterilization is that form of disinfection where the agent used is heat in some form or a liquid chemical, having germicidal properties.

An object is said to be *sterile* when it is deprived of the power of producing bacteria.

It is essential in practical disinfection that we should maintain a tolerably fixed relation between the amount of the given disinfectant used and the amount of matter to be disinfected, in order that an excess of either may not exist, as, if we use an insufficient amount of a disinfectant we may only produce an antiseptic effect and not a complete disinfection. The list of substances possessing germicidal properties is large, but those worthy of confidence are few.

In order to prevent the spread of an infection it is of the greatest importance that complete disinfection be carried out from the beginning, hence competent and intelligent nursing is of primary importance, and it is not too much to say that if we completely disinfect all material that becomes infected, and all excretions, from the first, we will render the general disinfection much less unsatisfactory.

It is probable that protracted exposure to air and light

will ultimately destroy most, if not all, pathogenic microbes, although under favorable conditions the virus of tuberculosis and other transmissible diseases has been shown to retain its vitality for many years. It would seem also that mere diffusion in the atmosphere may render the virus inert. Typhus attacks a very large proportion of those who come into close contact with typhus patients, but rarely spreads under other conditions, even if the isolation is imperfect. Smallpox, on the other hand, is believed to be carried by air currents for a long distance under favorable conditions. Spores of pathogenic bacteria would doubtless be among the most resistant, but mechanical portability (influenced by the form of the microbe and the size and weight of the epithelial scales or other particles to which the microbe may be attached), the dryness (or the reverse) of the air, and the chemical effect of the atmospheric oxygen, are possible factors, and it is at all events conceivable that a certain minimum "dose" of virus is necessary for infection, so that mere dilution beyond a given point would render the virus harmless, even without destroying its vitality.

According to Koch, mere drying kills cholera bacillus. The complete disappearance of measles and other infections diseases from a district, often long periods after a widespread epidemic, is in itself a sufficient proof that an enormous amount of contagion does in some way or another speedily become inert, apart from all attempts at disinfection and exhaustion of available susceptible material.

Mechanical removal of infection from rooms or garments is often an important adjunct to disinfection

proper. Walls are stripped of paper, or scraped, or rubbed with dough, or washed; floors are washed or swept; a strong current of air is sent through the room; garments are washed or brushed, or beaten, and hung out in the open air. As a rule, such measures, though effectual as far as they go, are in themselves incomplete safeguards, since some portion of the virus may escape dislodgment, and there is no certainty as to the future harmlessness of the rest.

True disinfection, that is, the destruction of the germs, may be divided into four general classes, as follows:

Physical disinfection,
Mechanical disinfection,
Thermal disinfection,
Chemical disinfection.

CHAPTER XI.

SPECIAL PROCESSES.—Continued.

Physical Disinfection.—Physical disinfection means the destruction of germ life by means of natural influences, such as sunlight, natural electricity, etc.

Physical disinfection is valuable to us from any standpoint. From the standpoint of the embalmer it is an essential subject, since it deals with nature's way of securing pure surroundings for the living, and any subject pertaining to the purity of the air must needs be important to embalmers, who are sometimes compelled to work under the handicap of impure air.

Described as a part of physical disinfection we find the disinfecting processes of nature. It may not have occurred to you previously that exposing a room to sunlight is one of the most powerful ways we have of proceeding against the life of pathogenic germs within that room.

The discharge of lightning produces ozone, an allotropic form of oxygen characterized by the metallic odor in the air after a hard electrical storm. Ozone produced in this way is a very effective agent in the natural purification of the air.

Germ life demands moisture for its very existence. Under these circumstances, any form of dryness is a natural impediment to the life of germs.

Understanding the natural forces against the life of germs, we can have a broader conception of the importance of sanitation as a man-made power against disease.

Light.—That light affects the metabolism of living cells is well known, and the various reactions to light that are exhibited by the higher organisms have been the subject of much investigation.

In connection with the study of bacteria the germicidal influence of light has received most attention.

Diffused sunlight has been found to exercise a hindering effect upon bacterial growth and matabolic activity.

Direct sunlight is highly injurious to certain forms of bacterial life, many organisms being killed almost instantly when exposed to the full action of the sun's rays. Sunlight is an active germicide, and its destructive action is not only confined to bacteria, but also to spores. The importance of the sun's rays in preventing and destroying the development and growth of microorganisms in nature can not be over estimated. Unfortunately the sunshine is so uncertain and the force of the sun's rays so variable, and their disinfecting power so superficial, that it can not be depended upon as an aggressive measure in attacking infection in rooms and confined spaces.

Sunshine comes more under the jurisdiction of the sanitarian than of the disinfector, but the latter can always use it to advantage in supplementing his other methods, and especially in out-of-the-way places. Rooms and objects may always be sunned and aired to advantage after disinfection. As an example of the germicidal powers of sunlight, we will quote Pansini, who in 1890 published the results of his experiments to determine the

action of sunlight on the following microorganisms: bacillus anthracis, prodigiosis, pyocaneus, violaceus, muricepticus chorela and staphylococcus albus. He found that even the diffused light had marked effect in restraining the growth of these bacteria after it had acted twenty-four to forty-eight hours. Direct sunlight acting perpendicularly on the cultures, sterilizes them all within one day. When the sunlight acted obliquely it was necessary to expose the cultures several days to sterilize them completely.

That the unfavorable influence of sunlight is not due to the heat rays is shown by the use of a screen (alum solution) which intercepts the heat rays but allows the germicidal rays to pass through. The blue and the violet rays have the most marked germicidal power.

The action of light on bacteria has been picturesquely shown by protecting certain portions of colonies of bacteria in plate culture and allowing the rest of the plate to receive the full effect of the sun's rays. If properly handled, plate colonies of bacteria will develop in the shaded portions, but no colonies will appear in the exposed portions.

The germs of plague and cholera die more quickly than those of tuberculosis. Spores are very much more resistant to the action of the sun's rays than the bacterial cells themselves. A good example is found in the time required to kill an anthrax spore and bacillus. It requires thirty hours to kill anthrax spores, while two hours may be sufficient to kill the bacteria.

Just how the light kills bacteria is difficult to explain satisfactorily. That the action is chemical seems likely,

from the fact that the ultra-violet rays of the spectrum are endowed with this power.

Natural Electricity.—The action of the discharge of electricity contained in the lightning's flash is one of the most potent disinfectants and deodorizers ever observed.

You have perhaps gone out on the street shortly after a severe electrical storm, where the discharge of lightning has rent the clouds and atmosphere and have noted the peculiar metallic odor present, which resembles that of a pine forest, or the atmosphere of Colorado or some of the localities of a highly electrically charged atmosphere.

The odor described is that of the natural disinfectant, germicide and deodorant called "ozone."

Ozone is formed by the subjecting of the air to high electrical pressure.

Natural Dessication.—Natural dessication only at times acts as a disinfectant. It is given here to show how resistant some forms of germ life are to the natural processes of drying, and to show that strenuous efforts should be made to disinfect these resistant forms of bacterial life.

Many of the higher forms of life display considerable resistance to drying. The small aquatic worms, known as rotifers, will revive after months and even years of prolonged dessication.

Seeds of the higher plants, which are specially adapted for resistance to drying, rarely outlast ten to twenty years.

Most of the vegetative forms of bacteria are rather quickly destroyed by ordinary drying, although there are great differences among the different forms. The

tubercle bacillus is one of the more resistant, and the cholera spirillum is one of the most sensitive to drying.

Exposure to dessication for a few hours, or at most a few days, destroys the majority of pathogenic microorganisms, so that infection through the air, except where floating bacteria are protected by their position within the epithelial scales or in droplets of moisture, is not so common as popularly supposed.

The spores of bacteria are much more resistant to drying than the vegetable forms. The spores of anthrax will germinate after remaining in the dry condition for at least from ten to twenty-five years.

Atmospheric Pressure.—Pressures of 600 to 700 atmospheres are said by some observers to have an inhibitory effect upon the putrefactive processes, but on the other hand, others state that living microorganisms are not effected by exposure for twenty-four hours to a pressure at 600 atmospheres. Roger says a pressure of 2,000 atmospheres lessens the virulence of the anthrax bacillus.

The effect of pressure can not be said to have been fully determined.

CHAPTER XII.

SPECIAL PROCESSES.—Continued.

Mechanical Disinfection. — Mechanical disinfection means the destruction of germ life by means of mechanical processes, such as electric currents, filtration, etc.

Electric Currents.—The action of electricity on bacterial life has been closely studied by experimenters, only to arrive at contradictory results.

Some very great claims have been made for the effects of different currents, but the latest researches have shown these to have been founded on error.

It has been proven that electrical currents have very little germicidal action in themselves, and that the apparent effects are due more to the heat generated by the current or to electrolytic action.

Experiments made to determine the effect of the electric current upon bacteria have been in too many cases conducted loosely and inferences have been drawn that have not been warranted by the conditions of the experiment.

In some instances, when a small amount of water is used, a rise in temperature is produced which is sufficient to account for the death of bacteria. In other cases death is due to the action of strongly germicidal substances like chlorine and ozone, which are liberated by the passage of the electric current.

When the effects due to heat and to the electrolytic production of germicides are eliminated, it is very doubtful whether any direct action can be properly attributed to the electric current.

The Roentgen rays have not been definitely shown to exert any germicidal effect. The results obtained by surgeons must be possibly attributed to the "ozone" formed by the discharge of the current, or perhaps to the production of hypo-chlorous acid, organic hyper-oxides, etc.

Electric Light.—The electric light exerts a germicidal influence similar to that of the sun's rays, but the action of a 900 candle power light is weaker than that of the sun's rays.

The time required for light to arrest multiplication and for the destruction of germ life is far from being definitely fixed. There are many conditions besides the brightness of the light to consider when determining the germicidal power. Such conditions as moisture, temperature, and transparency and thickness of the media, etc., aid or hinder the action of the rays, and the length of exposure for different microorganisms must also be considered.

Filtration.—Filtration has earned recognition as a mechanical form of disinfection. Used in water purification, it has reduced the possibility of infection from water-borne diseases to the smallest possible perecentage.

The germ of typhoid fever is one of the water-borne germs against which filtration is directed. For small filters, porous artificial stone is used; the water in passing

through the pores leaves the impurities in the stone. The stones are cleaned from time to time so as to secure the purest conditions and the best filtration.

In large filtration projects, such as the filtration of the entire water supply of a city, the water is first conducted into settling basins, where the foreign impurities settle and leave the clear water above. After this the water is conducted into filtration beds and passes through gravel, etc., until it finally emerges as pure as water can be made. Chemicals are frequently used to assist the purification.

The efficiency of the filtration processes, especially in some of the larger cities, is entirely responsible for the constantly decreasing death rate from typhoid.

A concrete example of simple filtration by means of natural influences is seen in the little stream which may have its origin in the barnyard. Here the water is green and putrid and teems with bacteria. The little stream now flows down through the meadow, over the pebbles, sand, through leaves, until it finds its way into the woods. Here we will stoop down to drink the cool, sparkling water, and it is pure and wholesome, and we do not get a disease.

The water which was putrid in the barnyard is pure in the woods, and has been made so by nature's own process of filtration and the germicidal action of the sun's rays, also the nitrifying action of bacteria.

Ozone.—As a mechanical disinfectant, it is used to some extent in water purification. The production of ozone requires large and expensive apparatus to electrify currents of air. This causes first a splitting up of the

oxygen atoms from the nitrogen, and then a concentration of oxygen atoms results in the production of ozone. Ozone contains three atoms of oxygen to every molecule. Oxygen in its free state contains only two atoms to every molecule. In air we have two atoms of nitrogen coupled with one atom of oxygen to every molecule. The composition of air is expressed by the formula N_2O.

On account of the expense of producing ozone, it is used very little in actual practice excepting for the deodorization of air in rooms, etc.

CHAPTER XIII.

SPECIAL PROCESSES.—Continued.

Thermal Disinfection — Sterilization. — Heat, in one form or another, is one of the most trustworthy germicides that we possess. We rarely speak of thermal disinfection as the term generally applied to this form of disinfection is called sterilization.

Sterilization is that form of disinfection where the agent used is heat in some form.

Thermal disinfection or sterilization is usually divided into dry and moist heat. Dry heat is much less effective as a germicide than moist heat. The difference doubtless depends upon the fact that chemical or physical changes that cause the coagulation of protein, or the death of the protoplasm, take place, like such reactions generally do, more readily in the presence of water.

Dry heat is divided into flame and hot air, and moist heat is divided into boiling water, steam, and steam under pressure.

$$\text{Sterilization}\begin{cases}\text{dry heat} & \begin{cases}\text{flame}\\ \text{hot air}\end{cases}\\[2ex] \text{moist heat} & \begin{cases}\text{boiling water}\\ \text{steam}\\ \text{steam under pressure}\end{cases}\end{cases}$$

Heat, then, is employed according to circumstances as ordinary fire with free flames; as dry hot air, the articles to be disinfected being protected in a properly constructed oven; as boiling water; as streaming or live steam; and, as steam under pressure.

Flame, or Burning.—All infected material which has but little value should be burned as the best means of preventing the spread of the disease. Fire is a great purifier; burning, however, has a very limited range of usefulness in practical disinfection. The free flames are resorted to only when it is desirable to consume valueless articles completely, which would hardly pay for the trouble of disinfecting by usual processes, for example, old straw mattress, worn-out clothing, useless furniture or bedding, etc. Although there are times and circumstances where it may seem necessary to burn an article in order to destroy all vestiges of germ life, yet the advances made in science of germ destruction has been so rapid that the disinfector should never consign anything to the flames against the wishes of the owners, for we now possess methods by which objects may be rendered safe as far as the conveying of disease is concerned.

In the actual practice of his profession, however, the disinfector should treat rubbish and articles of no value with fire, which will be the safest, cheapest and best method of disposing of them from a sanitary point of view. This method is also the best in a locality where a pestilent disease prevails.

Dry Heat.—The process of disinfection by dry heat in ovens constructed for the purpose was formerly much

more in vogue than at the present time. It has been practically abandoned for the reasons that dry heat has but little penetration power as compared with steam; that it requires a longer time for penetration and disinfection

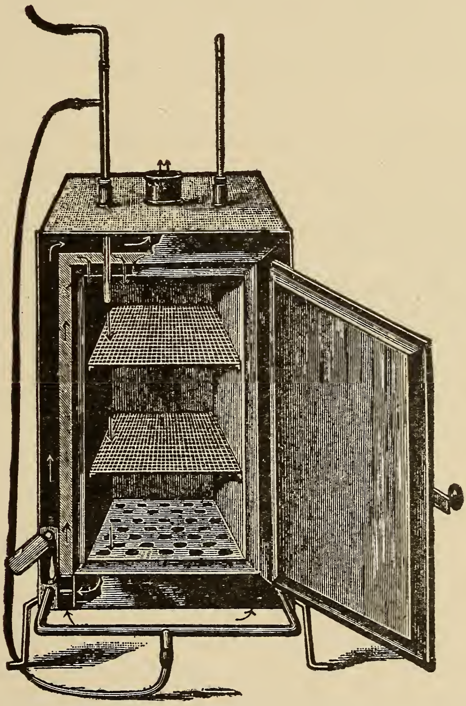

Fig. 7.—Hot air sterilizer (McFarland's Pathogenic Bacteria).

than is necessary for steam; and that the high temperature and the prolonged exposure are together detrimental to many articles that are disinfected by this process.

In a dry atmosphere, a temperature ranging from 140 *to* 180 *degrees Centigrade must* be employed to insure

sterilization if continued for *one hour.* All forms of germ life, even the most resistant spores will be killed at this temperature.

It is easy to maintain this temperature in an apparatus of special construction known as the hot air or the dry wall sterilizer. This method is used by many surgeons and embalmers to sterilize their appliances, such as glassware, etc.

Such an apparatus can be obtained at only a little expense. Procure an ordinary gasoline oven and line it with asbestos, through the top, cut a hole into which you are to insert a cork, then cut a hole through the cork and insert a thermometer which will register as far as 300 to 500 degrees Centigrade. Then place such articles as can be sterilized by this method without injury, as glassware, etc., in the oven, then place the oven over the fire, being careful to watch the thermometer, for fear the heat will increase too far and break the thermometer.

A dry heat somewhat less than 140 degrees Centigrade is sufficient to destroy many pathogenic bacteria, especially the non-spore bearing variety, which are the cause of most of the epidemic diseases to which mankind is liable.

Dry heat or hot air it not so reliable a disinfectant as other forms of moist heat, especially as it lacks penetration, and is injurious to fabrics. Most materials will bear a temperature of 110 degrees Centigrade, (about 230 degrees Fahrenheit) without much injury, but when this temperature is exceeded signs of damage soon begin to show. Scorching begins sooner with woolen materials, such as flannels and blankets, than with linen and cotton materials. The oven drying of fabrics renders them very

brittle, but the injury may be lessened by allowing them to remain in the air long enough for them to regain their natural degree of moisture before handling them. Hot air or dry heat fixes many stains so that they will not wash out. This is especially marked with albuminous materials coagulated by heat, and the method should not be used with objects stained with blood, sputum, excreta, or similar substances.

Hot air apparatus labors under a three-fold disadvantage as compared with steam.

(a) The available temperature and duration of exposure are limited by the tendency to scorch the articles exposed.

(b) The penetration of heat is so slow that it is practically impossible thoroughly to disinfect objects of moderate thickness, such as pillows; and lastly,

(c) The germicidal effect of a given temperature is far less with hot air than with steam.

The only advantage that can be claimed for hot air is that leather and bound books are not spoiled by it as they are by steam.

Boiling Water.—The spore forms of bacteria are always much more resistant to the action of heat than the vegetative forms, and some species of bacteria when in the spore stage can withstand the temperature of boiling water for upwards of sixteen hours. The vegetative forms of most bacteria on the other hand are killed at a temperature of 55 to 58 degrees Centigrade and the most resistant by a 30 minutes' exposure to boiling water.

Boiling is such an every day process that it is often neglected in practical disinfection, despite the fact that

it is the readiest and the most effective method of destroying infection. Boiling is particularly applicable for the disinfection of bedding, body linens, towels and other fabrics, eating utensils, etc.

You can greatly increase the disinfecting power of boiling water by adding a small amount of bichloride of mercury, carbolic acid, 1 or 2 per cent. of soda, or any of the soluble germicidal agents. The addition of lye, borax, or strong alkaline soap will also increase the penetrating power of boiling water.

In as much as spores are resistant, it is best to use them as a standard, and then if we can kill all spores, we are doubly sure that we have a complete disinfection. This can be brought about by the discontinuous method of disinfection. Boil the clothing on three successive days for one hour each day. After the boiling of the first day many of the spore forms will germinate which will be killed by the boiling of the second day, between the second and the third day still more will germinate which may be killed by the boiling of the third day, so that we are at last sure that by the three successive boilings all the spore forms are killed.

But in many cases this is not necessary, for we may know the germs we are trying to kill, and if they are non-spore bearing we may feel safe to simply boil the material containing them for 30 *minutes at* 100 *degrees Centigrade.*

Complete immersion in boiling water tightly covered for 30 minutes will remove from clothing, dishes, etc., all known forms of disease germs.

The addition of 1 per cent. of C. P. carbonate of soda

solution renders the process applicable for polished steel, cutting instruments, or tools.

Steam.—Steam is a most valuable disinfectant. It is reliable, quick, and may be depended upon to penetrate deeply. In practice the problem of disinfection is almost always complicated by the fact that the virus is not exposed freely, but enclosed in garments, pillows, or even beds; that is, in more or less bulky articles made of materials that have been selected for use as being the worst conductors of heat. It is found that steam rapidly penetrates into the interior of such objects.

Another important consideration is the effect upon the color and texture of fabrics exposed to heat. Articles composed in part of fusible substances, such as glue or sealing wax, are of course, ruined by heat in any form. Steam is inadmissible for leather objects, since it shrivels them up and renders them worthless; hot water merely makes them temporarily dry and brittle. With these exceptions, steam is less injurious than hot air in almost all respects. New woolen goods, such as blankets and flannels, lose some of their whiteness and fleeciness by either process, but not more than in one or two ordinary washings. Silk and cottton are not injured by steam. Dyes are but little effected by steam. For the disinfection of bedding and fabrics of all kinds, and a variety of other objects, steam is applicable, and does no particular harm.

A simple way of producing free steam for the disinfection of small objects, such as body or bed linen and other fabrics, may be accomplished in this way. Secure a common wash boiler, place on kitchen stove, and put three or four inches of water therein. Then arrange broom

handles across the top to hold the articles to be disinfected. The whole should be covered with a sheet or some other cover to retain the heat and steam.

To kill all spores by this method, it is best to steam the articles *one hour each day for three consecutive days*. This is called the *discontinuous method.*

For non-spore bearing disease germs it is sufficient to *simply steam for one hour at* 100 *degrees C.*

The addition of some salt to the water will raise the boiling point and the steam will therefore be given off at a higher temperature than 100 degrees C. which will add to the effectiveness of the method.

It is essential that any apparatus for disinfection by heat should have doors at opposite ends, opening into separate rooms provided with separate entrances. One of these rooms should be strictly reserved for infected and the other for disinfected goods, and no articles should on any account be allowed to enter the latter room except through the stove, the object being of course to guard against the danger of reinfection of the purified articles.

Steam Under Pressure.—If steam under pressure be used as the autoclave, exposure for fifteen minutes to a temperature of 125 degrees Centigrade is sufficient to destroy all forms of known microbes and spore forms.

Steam under pressure is a more powerful disinfectant than any other form of heat. At a pressure of fifteen pounds to the square inch, steam has a temperature of approximately 120 degrees Centigrade and will sterilize in fifteen minutes.

In laboratories and surgical clinics the Arnold steam

sterilizer or Koch steamer is generally used for the disinfection of all dressings, etc.

Remember that disinfection with steam depends upon the temperature of the steam and the length of time you expose the material to be disinfected, to the steam. If you use a low temperature you must expose your material longer. If you use a high temperature you need not expose your material so long.

How to Change a Fahrenheit Scale to a Centigrade Scale and Vice Versa.—In the discourse on the various effects of chemicals in regard to temperature relations, we speak of the different thermometers Centigrade and Fahrenheit.

The Centigrade thermometer is the one generally used for scientific work and has these important markings:

(a)—Freezing point is at 0 degrees.

(b)—Boiling point is at 100 degrees.

(c)—And between these two points the scale is divided into just 100 equal divisions.

The Fahrenheit thermometer is the one generally used for the household and by physicians in taking temperatures of the body and has these important markings:

(a)—Freezing point is at 32 degrees.

(b)—Boiling point is at 212 degrees.

(c)—And between these two points the scale is divided into just 180 equal divisions.

(d)—That 0 degrees is just 32 degrees below the freezing point.

Thus you see that one division on the Centigrade scale is just 9/5 of one division on the Fahrenheit scale, or vice

versa, one division on the Fahrenheit scale is just 5/9 of one division on the Centigrade scale.

Also that freezing point on the Fahrenheit scale is just 32 degrees above zero point on that scale.

These points must be taken into consideration in changing one scale into another.

We have then two rules to learn.

(1)—To convert Fahrenheit to Centigrade.

Rule—From the Fahrenheit temperature given subtract 32, multiply by 5, and divide by 9:

Problem: Convert 98.6 F. to Centigrade,

98.6 minus 32 equals 66.6 multiplied by 5 equals 333, divided by 9, equals 37. degrees.

$98.6 - 32 = 66.6 \times 5 = 333 \div 9 = 37.$

or,

Rule—$C = 5/9\ (F - 32).$

$C = 5/9\ (98.6 - 32).$

$C = 5/9\ (66.6).$

$C = 37.$

(2)—To convert Centigrade to Fahrenheit.

Rule—Multiply the Centigrade scale by 9, and divide by 5, and add 32.

Problem: Convert 37 C. to Fahrenheit.

37 times 9 equals 333, divided by 5 equals 66.6, plus 32 equals 98.6 degrees.

$37 \times 9 = 333 \div 5 = 66.6 + 32 = 98.6.$

or,

Rule—$F = 9/5\ (C) + 32.$

$F = 9/5\ (37) + 32.$

$F = 66.6 + 32.$

$F = 98.6.$

CHAPTER XIV.

SPECIAL PROCESSES.—Continued.

Chemical Disinfection.—Chemical disinfection means the destruction of germ life by means of certain chemicals which have come into general usage because of their peculiar properties in this regard. A chemical to be of practical value must not only be strongly germicidal as shown by laboratory experiments, but must also meet the many exacting requirements of the general practice, and such chemical substances are few in number.

Chemical disinfection has been shown by the accurate experiments of Koch and others to be a matter of considerable difficulty, and comparatively few of the so-called disinfectants in common use prove to be really germicidal under the conditions of actual practice. A convenient but severe test is to expose to the disinfectant, for a definite period, threads which have been soaked in a cultivation containing anthrax spores and then dried. After the disinfection, cultivation or inoculation experiments show whether the spores survive or not, control experiments being made at the same time. Among the very few substances which killed the spores within a day (and for practical disinfection this is far more than can often be allowed) were mercuric chloride (1 per cent.), carbolic acid and potassium permanganate (5 per cent.), and chlorine and bromine water. A 4 per cent. solution of

carbolic acid took three days, and 1 per cent. permanganate had no effect in two days. Among those which failed were 5 per cent. solutions of chloride of lime, zinc salts, copper sulphate, ferrous sulphate, boracic acid, and sulphurous acid, and 5 per cent. carbolic oil. Several of these, however, are able to kill less resistant forms, such as sporeless anthrax bacilli; or, serving as antiseptics, to prevent multiplication. A substance, to be a satisfactory disinfectant, should possess five characteristics:

(a)—It should be germicidal within a reasonable time limit.

(b)—It should not possess chemical properties which unfit it for ordinary use.

(c)—It should be soluble in water, or capable of giving rise to soluble products in contact with the material to be disinfected.

(d)—It should not produce injurious effects on the human tissues.

(e)—It should not be too costly in proportion to its germicidal value. The substances which fulfill all these requirements are not numerous. Many valuable experiments have been made respecting such chemical bodies, because the conditions necessary to valid and comparable results have been ignored. These conditions are chiefly three, namely, using disinfectants which give regular and consistent results, using standardized bacterial cultures as to age and source and working with the same organisms. Out of the confusion of contradictory findings it is possible, however, to name a number of reliable disinfectants. The liquid reagents most in use are mercuric chloride (1 : 500), potassium permanganate (5 per cent.), formalin

(5 per cent. solution), carbolic acid (5 per cent.), zinc chloride (2.5 per cent.), cresol, lysol, creolin and many compounds of the aromatic series (e. g. Jeyes' fluid, which contains the higher phenols, and forms emulsions with water).

A most important consideration in regard to the more potent reagents forming the first series, is their working strength. If, for example, it is proposed to disinfect a putrescent liquid by means of permanganate of potash, it is absolutely useless to add a little 5 per cent. solution of the salt. We must add either the solid permanganate or a highly concentrated solution, until the permanganate is present as such to the extent of 5 per cent. of the whole weight of liquid, this five per cent. being of course in addition to the amount required to oxidize the organic matter. These essential conditions are rarely if ever observed in practice, and disinfection by permanganate consists really of deodorization with partial oxidation of organic matter. A similar consideration applies to mercuric chloride, which, if added to liquids containing organic matter, forms a precipitate that carries down part of the mercury in an inert form, and if sulphuretted hydrogen is present, the equally inert sulphide of mercury is thrown down. So, too, with carbolic acid, which must form not less than 5 per cent. of the whole weight of liquid—not merely of the stock solution—if it is to destroy anthrax spores.

Mercuric chloride is one of the chief reagents that can be conveniently employed in solution under such conditions as to destroy the most resistant microbes. One part of mercuric chloride in 1,000 parts of water destroys an-

thrax spores, according to Koch, but other observers have found this strength inadequate. The great drawback to this reagent is its extremely poisonous nature, but it may be kept in poison bottles properly labeled, and the solution may be artificially colored with indigo, and odorized with thymol, as further safeguards. The following proportions are suggested:

Mercuric chloride	½ ounce
Hydrochloric acid	1 ounce
Aniline blue	5 grains
Water	3 gallons

This ought not to cost more than one penny per gallon and should not be further diluted. Non-metallic vessels (wooden or earthenware) should be used. Articles soaked in the mercurial solution should be steeped in water for some hours before washing.

Many fluid disinfectants are now applied direct to infected surfaces by means of a sprayer, such as chloride of lime (1 lb. to ten gallons of water), carbolic acid 5 per cent., formalin (40 per cent. solution, 4 oz. to the gallon).

Chemicals may be either solids, liquids, or gases, and because of this fact it has been thought best to divide chemical disinfectants into the following classes:

Solid disinfectants.

Liquid disinfectants.

Gaseous disinfectants.

Classification of Chemicals.—The following table has been arranged to give the undertaker and the embalmer some idea as to the chemicals used by the profession. An attempt has been made by the authors to classify these

chemicals as gaseous, liquid, solid disinfectants, preservatives, antiseptics, insecticides, blood solvents, bleachers and deodorants, or their use in embalming fluids or hardening compounds.

NAME OF CHEMICAL	Gaseous disinfectants	Liquid disinfectants	Solid disinfectants	Preservatives	Antiseptics	Insecticides	Blood solvents	Bleachers	Deodorants	Embalming fluid	Hardening compound
Acetic acid					X			X			
Alcohol				X	X					X	
Alum					X			X		X	X
Aluminic acetate					X					X	
Aluminic chloride					X						
Ammonium chloride					X						
Ammonium muriate										X	
Ammonium sulphate					X						
Arsenate of soda				X	X						
Arsenic				X		X				X	
Arsenite of potassium					X						
Arsenous acid				X	X						
Ashes									X		
Benzoic acid					X						
Benzoin										X	
Bichloride of mercury		X			X					X	
Bisulphide of carbon						X					
Boracic acid				X	X		X	X			
Borax					X		X	X			
Boroglyceride										X	
Bromine	X										
Calcium chloride					X						
Camphor					X						
Carbolic acid		X			X				X	X	

NAME OF CHEMICAL	Gaseous disinfectants	Liquid disinfectants	Solid disinfectants	Preservatives	Antiseptics	Insecticides	Blood solvents	Bleachers	Deodorants	Embalming fluid	Hardening compound
Cetric acid								X		X	
Charcoal									X		
Chloral hydrate					X		X			X	
Chlorides ("Platt's")									X		
Chlorinated lime									X		
Chlorine	X				X			X	X		
Chromic acid					X						
Copper sulphate					X				X		
Creosote					X					X	
Cresols		X									
Danyz virus						X					
Earth									X		
Ether					X						
Ethylacetate								X		X	
Ferrous sulphate					X						
Formaldehyde	X	X		X	X				X	X	
Glycerine					X					X	
Guaiacol										X	
Hydrochloric acid					X			X		X	
Hydrocyanic acid	X				X	X					
Hypochlorites		X									
Lead chloride					X						
Lead nitrate					X						
Lime			X						X		
Magnesium sulphate										X	X
Mercuric iodide					X						
Milk of lime		X									
Nitrous acid	X										
Osmic acid					X						

NAME OF CHEMICAL	Gaseous disinfectants	Liquid disinfectants	Solid disinfectants	Preservatives	Antiseptics	Insecticides	Blood solvents	Bleachers	Deodorants	Embalming fluid	Hardening compound
Oxalic acid								X			
Oxygen	X										
Ozone	X										
Peroxides					X			X		X	
Petroleum						X					
Phenol					X						
Potassic arsenite					X						
Potassic bichromate					X						
Potassium chloride										X	
Potassium nitrate					X		X	X		X	
Potassium permanganate					X				X		
Plaster of paris									X		X
Pyrethrum						X					
Salicylic acid				X	X					X	
Saw dust									X		X
Soaps					X						
Sodium bicarbonate (caustic soda)					X		X			X	
Sodium chloride				X	X		X				
Sodium hyposulphite					X						
Sodium sulphate							X	X			
Sulphur	X		X			X		X			
Sulphuric acid					X						
Sulphurous acid					X						
Tannic acid					X						
Thymol					X			X	X	X	
Turpentine					X						
Zinc chloride					X					X	
Zinc sulphate					X					X	X
Zinc sulphocarbolate										X	

CHAPTER XV.

SPECIAL PROCESSES.—Continued.

Gaseous Disinfectants.—A few of the gaseous disinfectants worthy of mention are: formaldehyde, bromine, sulphurous acid gas, nitrous acid, hydrocyanic acid, chlorine oxygen and ozone.

A gas is the ideal agent for the destruction of infection which may be brought about by pathogenic bacteria. By reaching all portions of a room or a confined space, it lessens the risk of overlooking any surface upon which the infective agent may be lodged.

There is practically only one gas that is suitable for general application, viz., formaldehyde. This substance comes nearer being the ideal disinfectant than any of the gases so far in use. Formaldehyde is not poisonous, does not injure fabrics, colors, metals, or objects of art or value.

Sulphurous acid gas is too destructive to fabrics, colors, metals, for it to have a very general use. It is very poisonous to all forms of animal life, which makes it particularly valuable for the disinfection against insect borne diseases. It probably has no equal for the disinfection of the holds of ships, cellars, sewers and other rough structures infested with vermin.

Chlorine gas is very poisonous and too destructive for it to have a very wide range of usefulness.

Hydrocyanic acid can not be used in the household at all with safety because of its inflammable and explosive nature, and in practice is limited to the destruction of infection and vermin on board ships, in warehouses, granaries, greenhouses, and other uninhabited places.

None of the gaseous agents can be depended upon for more than a surface disinfection, as they lack the power of penetration.

Formaldehyde Gas.—Formaldehyde gas is the most useful and one of the best disinfecting agents that we possess. Its superiority depends upon its high value as a germicide, its non-poisonous nature, and upon the fact that it is not destructive.

The secret of successful disinfection with this substance, is to obtain a large volume of the gas in a short length of time, and at the present writing the ideal formaldehyde generator is an unsolved problem. When failures come with its use, it is usually a result of an imperfect knowledge of its properties, its limitations, and its methods of destruction, because it is a very complex and unstable gas.

Formaldehyde exists in three well recognized forms, viz.:

CH_2O	CH_2O CH_2O	CH_2O CH_2O CH_2O
Formaldehyde gas	Formaldehyde paraform	Trioxymethylene

(1) Formaldehyde is a gas at ordinary temperatures, colorless, and possessing slight odor, but having an extremely irritating effect upon the mucous surfaces of the nose and conjunctiva. At a temperature of about—20 degrees C. the gas changes into what is known commercially as paraform.

(2) Paraform is a white substance, unctious to the touch, soluble in both water and alcohol. It consists chemically of two molecules of formaldehyde, and it is this substance which is supposed to compose the commercial solutions known as formalin.

(3) Trioxymethylene is formed by the union of three molecules of formaldehyde. It is a white powder giving off the strong odor of the gas, and is but slightly soluble in alcohol and water.

Formaldehyde gas possesses about the same specific gravity as air, which renders it poorly diffusible, although better than sulphurous gas and consequently it penetrates more quickly to all portions of the room.

As a germicide, it has the property of combining directly with the albuminoids, forming the protoplasm of the microorganisms. It is perfectly plain, therefore, why there must be direct contact between the gas and the germ in order to accomplish disinfection.

Because of its non-destructibility it is practically the only disinfecting agent which may be used in the richest apartments, containing objects of value, and art, without fear of injuring anything.

Disinfection with this gas should never take place at a temperature less than 10 degrees C., as the gas condenses at—20 degrees C. to paraform, consequently in

cold weather the room to be disinfected should be heated by artificial means, up to about seventy-five degrees F.

Moisture is necessary to obtain successful gaseous disinfection with this gas. Although the exact amount of moisture has not been determined, yet it is estimated that the full disinfecting power of formaldehyde gas is only obtained when the atmosphere is saturated to its maximum. It is therefore advisable in dry weather, to place a basin of boiling water in the room just before evolving the gas, and usually the apparatus on the market supplies means of producing watery vapor with the gas.

Formaldehyde cannot be depended upon to accomplish more than a surface disinfection, for under ordinary circumstances it possesses small powers of penetration. It takes a large volume and a long exposure to penetrate fabrics. The meshes tend to polymerize the gas and deposit it as a paraform upon the surface of the fabric. Large quantities of the gas are lost by uniting chemically with the organic matter of the fabrics, especially woolens, which also hinders its penetration.

Formaldehyde gas has the power of killing spores, although, not with sufficient certainty to render it a trustworthy disinfectant for the infection due to spore bearing bacteria.

Bacteria exposed directly to the concentrated action of the gas are destroyed almost instantly. Under similar conditions spores are sometimes killed within one hour. But in practical work it is necessary to prolong the time of exposure because the gas is evolved slowly from most of the forms of apparatus and it takes considerable time for it to penetrate all the corners and dead spaces of

a room. Bacteria and their spores are not always directly exposed upon the surface of objects, as they are in the laboratory experiments, and furthermore, they are frequently embedded in albuminous matter in the dust, which retards the penetration of the gas, and requires longer exposure. The length of time found necessary to kill infection will be given under the several methods for its use.

Formaldehyde gas is not toxic to the higher forms of animal life, although it stands at the head of the list of germicides. Long exposures to weak atmospheres of the gas, sufficient to kill germs, have but the slightest effect upon the mammalian animals. Guinea pigs, rats, mice, and rabbits, exposed to the most concentrated atmospheres obtained by any of the methods for evolving it, are not killed after half an hour's exposure. The only effect produced is a violent irritation of the mucous membranes of the respiratory tract, from which the animals may subsequently die. If microorganisms were exposed to the same concentration of the gas they would be killed instantly.

Formaldehyde is not a good insecticide. In the strongest volumes of the gas obtainable it seems practically to have no effect upon roaches, bed bugs, and the great majority of vermin of this class. It will kill mosquitoes in the strengths and the time prescribed for the bacterial disinfection, provided there is direct contact between the gas and the mosquito. (See insecticides, page 207.)

Formaldehyde is neutralized by ammonia.

Methods of Producing Formaldehyde Gas.—The following methods are given for the generation of formal-

dehyde gas, and their value as well as the advantages and disadvantages will be given in connection with each method.

The Direct Method.—Pass methyl alcohol (CH_3OH) over a highly heated surface, asbestos discs coated with finely divided platinum, and the partial oxidation that occurs gives rise to formaldehyde gas.

$$CH_2OH + O = CH_2O + H_2O$$

On this principle a number of lamps have been devised that have been used to some extent, but considera-

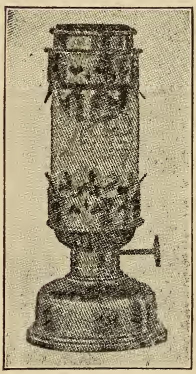

Fig. 8.—Formalin lamp (Rosenau).

tions of economy, and of ease and efficiency of application have prevented a very general introduction of this type of generator.

There are several disadvantages to the direct method:

(a)—It is of prime importance that almost all the vapor of the wood alcohol be changed to formaldehyde

gas. If much of the vapor of wood alcohol escapes into the air unaltered it is liable to take fire and result in serious consequences. In none of the generators so far devised is the amount of formaldehyde theoretically possible, obtained from the alcohol consumed.

(b)—It is also important to prevent the heat from the incandescent platinum flashing back and setting fire to the reservoir of alcohol which is used to feed the apparatus.

(c)—The gas is generated very slowly. It takes about two hours to convert three pints of wood alcohol, which is the amount required to disinfect 2000 cu. ft. of air space. When the gas is evolved so slowly it takes a long time for it to penetrate into all the nooks and corners of the room.

(d)—It therefore lacks the penetration power of the quicker processes.

One of the special advantages would be that nascent formaldehyde is liberated, and it is a well known fact in chemistry that reagents exert their most powerful effect when in this state.

Another advantage is that the manner of evolving the gas is free from the objection of some of the other processes in that there is less polymerization of the formaldehyde gas to paraform. Hence when a room is aired after the completion of the process, the unpleasant and irritating effects of the gas do not cling so persistently as in some of the other methods.

This method may be used for surface disinfection of rooms not over 2000 cu. ft. and of tight construction. Use not less than 25 ounces of the wood alcohol for each

1000 cu. ft of air space, and prolong the exposure not less than twelve hours, preferably twenty-four.

At the completion of the process there should be a distinct odor of formaldehyde gas.

The Paraform Method.—By heating, not igniting paraform, formaldehyde gas is evolved. Paraform will burn with a low, blue flame, but the resulting product of combustion contains no formaldehyde gas. In using this method to disinfect, it is therefore essential to heat the paraform to the point required to evolve the gas, but below the point of ignition.

The Schering lamp and formaldehyde generator consists simply of a metal pan in which the paraform is heated by an ordinary spirit lamp. The wicks must not project more than a twelfth of an inch, which is enough to give a flame that will heat the pan and its contents sufficiently to cause volatilization of the paraform without danger of combustion. Should the paraform ignite, no formaldehyde gas will be evolved and the object of disinfection will be defeated.

This method of evolving the gas is useful for the surface disinfection of closets and small inclosures, containing less than 1000 cu. ft. The space must be of tight construction, and all cracks and crevices must be carefully sealed. The exposure should not be less than twelve hours, and preferably twenty-four.

Use 3 to 4 ounces of paraform for each 1000 cu. ft. of air space.

The disadvantages of the method are that the gas is given off without moisture and tends to polymerize readily, especially on cold, dry days. The gas is also given

off slowly and with little force, so that it penetrates poorly to all nooks and corners of the room.

An advantage is that the method is simple and comparatively cheap.

The Key-hole Method.—Formaldehyde gas may be evolved from watery solutions by simply distilling it in a retort under pressure.

The method consists of an autoclave, which is a retort sufficiently strong to withstand the required pressure. The retort is usually made of copper, as the formaldehyde solution attacks the iron. There is a water gage and a pressure gage. The outlet tube ends in a small copper tube that may be introduced through the key-hole of the door. The retort is usually provided with a safety valve, to prevent accidents. Heat is applied to the bottom of the retort by means of a bunsen burner or any other means suitable. Too much reliance must not be placed upon the level of the water in the glass while using the apparatus under pressure, for in practice it is found to be untrustworthy.

The solution used in this apparatus consists of formalin 40 per cent., with the addition of 20 per cent. calcium chloride, or some other neutral salt, such as borax or common salt; 10 per cent. of glycerine may also be added. The neutral salt is added in order to prevent the polymerization of the formaldehyde, raise the boiling point and facilitate the evolution of the gas. Use not less than 16 ounces of the solution for each 1000 cu. ft. to be disinfected.

Practically all the gas is given off from this form of apparatus during the first part of the operation. It is

therefore necessary to charge the retort separately for each room to be treated.

Sometimes this form of apparatus squirts a hot liquid from the outlet tube, and provision must therefore be

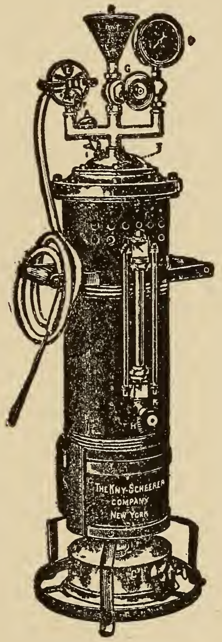

Fig. 9.—Autoclave for evolving formaldehyde under pressure (Rosenau).

made that nothing stands in line of the entering tube. Danger from this source may be obviated by hanging a towel a short distance in front of the tube and another on the floor to catch the drip.

The disadvantages of the method are that it requires

a rather heavy and somewhat cumbersome apparatus, and that it takes a skilled hand to operate it.

The method is applicable to rooms of any dimension, it being only a question of the size of the generator.

By this method one to five hours will be sufficient exposure to kill all non-spore-bearing organisms, providing the room has no articles of furniture or clothing in it. If such be the case, an exposure of twelve hours is necessary in order to insure penetration.

Simple Heating of Formaldehyde.—This method may be described the same as the key-hole method, excepting that the formaldehyde is evolved from the watery solution without pressure, and the apparatus is placed inside of the room instead of the tube running through the key-hole.

When formalin is boiled, the formaldehyde contained in the solution has a tendency to deposit as a powder instead of being driven off as a gas.

Upon first heating formalin the water is mainly evaporated, and subsequently the formaldehyde is disengaged. More of the disinfecting gas is evolved toward the end of the boiling than at first. In general practice, this point has a practical bearing when using the retorts without pressure. It is necessary to place the required amount of solution in the apparatus and to use it all. It will not do to fill the retort and use part of the gas and vapor evolved at first for the disinfection of one room and continue with the residue to disinfect another room, for the first might not get its full share of the formaldehyde gas.

The commercial solutions of formaldehyde are used in this apparatus. The addition of 1 per cent. of glycerine is

claimed to add to the efficiency when evolving in this way. The glycerine is added because it raises the boiling point and retards polymerization of formaldehyde in solution. It deposits as an imperceptible film upon the surfaces exposed. The film is supposed to favor the disinfecting power of the gas by holding it in direct contact with the bacteria.

Not less than 16 ounces of formalin, 40% for each 1,000 cubic feet of air space should be used, and an exposure of twenty-four hours is quite necessary for complete disinfection where fabrics are to be penetrated.

It requires about twenty-five minutes to distil 16 ounces of the solution from this apparatus. The gas escapes in a moist state, and it is therefore not necessary to add moisture to the room separately as in other methods.

The gas and watery vapor escape from the retort with considerable force, which aids diffusion and penetration. The method is therefore efficient for general application in disinfection whenever formaldehyde is indicated, particularly in rooms up to 5,000 cubic feet capacity.

Simple heating of formaldehyde in almost any kind of a vessel will give good results if a liberal amount of formalin is used. Use 16 ounces 40% formalin for 1,000 cubic feet air space, and add 10% glycerine to increase the penetrating and lasting powers.

The Sheet Method—Spraying.—Spraying is a very useful way of applying formaldehyde gas as a disinfectant, especially as it may be carried out without special apparatus. It has, though, distinct limitations, and unless

all the necessary conditions are carefully observed, spraying is a very untrustworthy method.

The formalin may be sprayed upon sheets hung up in a confined space, or it may be sprayed directly upon the object to be disinfected. In the latter case the object gradually becomes bathed in an atmosphere of the gas

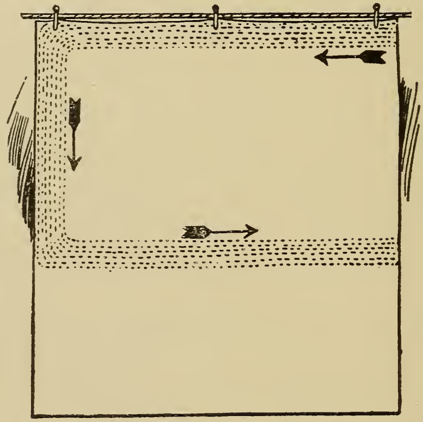

Fig. 10.—The sheet method (Embalmer's Monthly).

which is slowly evolved by the evaporation of the liquid, and it also receives the benefit of the direct contact with the germicidal fluid.

From watery solutions at the ordinary temperature, formaldehyde gas is given off very slowly, and in very uncertain quantities. It also diffuses slowly into dead spaces by this method. It is not applicable to large inclosures, nor to rooms having many drawers, nooks, or spaces where the gas would have difficulty in penetrating. The amount of the gas evolved from a given quantity of

sprayed solution is very variable, depending upon many conditions such as temperature, pressure, purity of solution, surface exposed and other less known factors.

In cold weather the formalin is apt to polymerize, and the water will evaporate from the solution sprayed upon the surface, leaving most of the formaldehyde as a white powder or solid residue. Hence the method should never be used except in warm weather or in rooms artificially heated. Warmth not only facilitates the evaporation of the fluid, but aids the disinfecting power of the gas.

The formalin should be sprayed in very small drops, which exposes a maximum surface for evaporation. Large splashes of the solution, applied by means of brushes, mops and the like, are less reliable.

A very common way to disinfect a room of small capacity is to spray not less than 16 ounces of formalin (containing 40% formaldehyde) for each 1,000 cubic feet air space, upon sheets suspended on lines across the room. Used in this way, a sheet 5 by 7 feet will hold about 16 ounces without dripping or the drops running together.

The room must be tightly sealed and kept closed for twenty-four hours. The method is limited to rooms not exceeding 2,000 cubic feet air space, because the gas is evolved so slowly, and there is more loss than can be be replaced by the slow evaporation, and the gas will not penetrate into the corners of large rooms with sufficient volume to insure its disinfecting action.

It requires some practice to apply the sprinkling method effectually. The gas is irritating, and it must be done quickly and at the same time carefully, so that the liquid remains on the sheets in small drops.

The sheets may be wrung out in the formaldehyde solution and hung up in the room, but while this method is simpler it can not be recommended as being as trustworthy as spraying.

The Formalin-permanganate Method.—In this method a large, open vessel is secured, with a flaring top, usually galvanized iron. This is placed within another vessel,

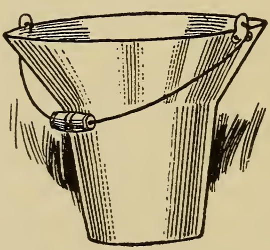

Fig. 11.—Bucket used in the formalin-permanganate method (Embalmer's Monthly).

preferably a tub, and place in this outside vessel a few inches of water, so that during the process of the evolution of the gas, should it boil over, the outside vessel will prevent the material from going on the floor and doing damage. Besides, the vessel in which the gas is evolved becomes very hot, and therefore the water in the outside vessel serves as a non-conductor of heat.

Place in the inside vessel 6¾ ounces of potassium permanganate. and pour over this 1 pint of 40% formaldehyde for 1.000 cubic feet of air space. This, after a few seconds, will begin to bubble and boil up with the evolution of the formaldehyde gas.

Remember that the potassium permanganate must go

in first, and that the temperature of the room ought to be above 60 degrees F.

The Formalin-quicklime Method.—In this method use an earthen vessel. Place in this vessel 2 or 3 pounds of quicklime. Pour over this 16 ounces of a 40% solution of formalin, together with 5 ounces of sulphuric acid, for 1,000 cubic feet of air space.

Sulphurous Acid Gas.—The custom of burning sulphur in infected rooms has the sanction of antiquity, and under certain conditions is reasonably effective.

Sulphurous acid gas is the active agent, and it is only when this agent is produced, that the disinfection is reliable.

Sulphurous acid gas is only produced when sulphur is burned in the presence of abundant moisture.

Simply burning sulphur gives a production of sulphur dioxide. Sulphur dioxide is not a disinfectant agent and as such should never be used.

Sulphur + heat = sulphur dioxide.
$S + 0 = SO_2$

To make this sulphur dioxide a disinfecting agent there must be an abundance of moisture.

Sulphur dioxide + moisture = sulphurous acid gas.
$SO_2 + H_2O = H_2SO_3$

The burning of sulphur, then, in the presence of moisture, has been found an effectual method of gaseous disinfection, and one upon which entire dependence can be

placed at all times in disinfection after diseases due to microorganisms not containing spores.

After the room has been prepared, reliable and cheap disinfection may be secured by the following methods of the use of sulphur:

Fig. 12.—The pot method of burning sulphur (Rosenau).

(1) Burn 3 to 4 pounds of sulphur in a vessel, in the presence of abundant moisture, as in Fig. 12 for every 1,000 cubic feet of air space.

A room ten feet long, ten feet wide and ten feet high has 1,000 cubic feet of air space. For a large closet use one pound of sulphur.

(2) Sulphur may be burned in shallow iron pots (Dutch ovens), containing not more than 30 pounds of sulphur for each pot. The sulphur pot should be elevated from the bottom of the compartment to be disinfected, in order to obtain the maximum possible percentage of combustion of the sulphur. The sulphur should be in a state of fine division, and ignition is best accomplished by alcohol. This method is especially applicable to cargo vessels, railroad trains, etc. Special attention and precaution should be given so that the material to be disinfected does not catch fire.

(3) *Water-jacketed sulphur* candles may be used instead of crude sulphur, but care must be taken to use sufficient candles. The average candle on the market contains one pound of sulphur. Three or four of these will be necessary to disinfect a room of 1,000 cubic feet. Do not use a less number, no matter what directions may accompany the candle. Partly fill tin around candle with water and place candle in pan on table, not on the floor, and let at least one-half pint of water be evaporated with each candle. Evaporate more if practicable.

There is one serious objection to the use of sulphur, and this must be fully understood The fumes of sulphur (sulphurous acid gas) have a destructive action on fabrics of wool, silk, cotton and linen, on tapestries and draperies, and exercise an injurious action on brass, copper, steel and gilt work. Colored fabrics are frequently changed in appearance and the strength impaired. Colored fabrics which have been in a room during disinfection should be immediately exposed to the sun and wind. Uncolored fabrics which will not be injured by moisture should be at once soaked in water. This will prevent the further injury from the action of the sulphurous acid gas.

Another disadvantage is that sulphurous acid gas lacks penetrating power, and besides, there is always a danger of setting fire to the floor and furniture unless proper precautions are observed.

The use of sulphur as a disinfectant has the advantage in that it will kill not only bacteria but insect life, such as flies, mosquitoes, etc.

(a) The infected rooms should be thoroughly closed, every crack and crevice sealed.

(b) Sufficient sulphur must be used.

(c) There must be moisture in the room.

(d) The time of exposure should be not less than six hours for the minimum.

Chlorine Gas.—There are several ways of making chlorine gas, as follows:

(a) *By the use of chlorinated lime*, commonly called, bleaching powder. By taking 3 to 4 pounds of this powder and adding one-half pint of hydrochloric acid, a free liberation of chlorine gas is obtained for 1,000 cubic feet.

$$CaOCl_3 + 2HCl = CaCl_2 + H_2O + 3Cl$$

This gas must be generated in an earthen dish.

(b) *By the use of peroxide of manganese.* To generate, take 4 ounces of peroxide of manganese (to be obtained at any drug store) and add 1 pound of hydrochloric acid for each 1,000 cubic feet of air space. The reagents must be placed in an earthen dish for generation of the gas.

(c) *By the use of sulphuric acid.* In practice, the most convenient method of generating the gas is by decomposing 1½ pounds of chloride of lime with 6 ounces of strong sulphuric acid. This produces a sufficient gas for the disinfection of 1,000 cubic feet of air space.

(d) The gas may also be generated from—

Common salt	8	ounces.
Manganese dioxide	2	"
Sulphuric acid	2	"
Water	2	"

Chlorine is a germicide of considerable but uncertain power. It has little practical usefulness, owing to its poisonous and destructive action. Both in its free state and in its watery solution it has very powerful deodorizing properties. In the free state, moisture is necessary for its action. At best the gas is but a surface disinfectant.

Chlorine is an extremely irritating gas, and great care must be observed in its employment, for the inhalation of very weak proportions of the gas produces serious irritation, resulting in spasm of the larynx, bronchitis, and even in death. Chlorine is heavier than air, and tends to fall, therefore the vessel generating the gas should be placed in an elevated position in order to obtain anything like an effective diffusion. Carpets, curtains and fabrics generally are injured by its action, and the element is a very active bleaching agent for all the organic colors.

The germicidal action depends upon its great affinity for hydrogen. So strong is this affinity that it combines with the hydrogen of water in the presence of light, liberating the oxygen in a free state, thereby enabling it to exert its power against organic matter.

Oxygen.—The disinfecting power of oxygen depends upon the physical state in which it exists. For instance, the oxygen in the air has feeble, if any, germicidal properties, while nascent oxygen and ozone are powerful germicides.

The germicidal action of oxygen depends upon its very active property of combining chemically with the albuminous matter of the cell protoplasm. The oxidizing properties of this element, acting upon organic matter

and converting a great part of it into carbon dioxide and water, explains the purifying power of fresh air.

Most bacteria, to grow and multiply, require the presence of oxygen. In this case they are called aerobic. There is a large class of organisms that will not develop in the presence of even minute traces of oxygen. In this case they are called anaerobic bacteria. In fact, the oxygen of the air acts as a poison or strong antiseptic for this class of vegetable life, among which are tetanus, anthrax, malignant edema germs, etc. On the other hand, oxygen has no appreciable effect upon the spores of these bacteria.

Ozone.—Ozone is the allotropic form of oxygen, containing three atoms of that element to the molecule instead of two. In sufficient concentration it is a powerful germicide, although there is not sufficient ozone in the air normally to exert any appreciable disinfecting properties.

Ozone is produced as a result of a discharge of electricity in the oxygen of the air.

In a mechanical way it is produced by passing an electric arc through the air. It has a peculiar metallic odor, familiar about electric dynamos. In this way it is not a fumigating agent, but is used more for the purification of the air in rooms or in public meeting-places.

Hydrocyanic Acid.—Hydrocyanic acid is used extensively in the disinfection of nursery stock and greenhouses, as well as in flouring mills, against weevils; in railroad coaches against bedbugs, and in tobacco warehouses against insects in general.

This gas is a fatal poison for all the forms of animal

life. It is much less destructive to vegetable life. It is a very powerful insecticide, but a weak germicide. Like the other gaseous disinfectants, it seems to possess no marked powers of penetration.

The extremely poisonous nature of hydrocyanic acid gas makes it necessary to exercise very great care in its employment. It should never be employed about the household. In practical disinfection it may be used in the treatment of stables, granaries, outhouses, the holds of ships and similar uninhabited places, for the destruction of insects.

The gas is lighter than air and has an agreeable, aromatic odor. It is best generated by the action of dilute sulphuric acid upon potassium cyanide in the following proportions.

Potassium cyanide,	1.0
Sulphuric acid	1.5
Water	2.25

The first step is to dilute the acid, which is best done by adding the acid to the water in a vessel capable of withstanding heat. The whole amount of the cyanide must be put into the acid at once, and as the evolution of gas is very rapid the operator must be ready to leave the spot immediately.

This gas has few advantages over sulphur dioxide in ridding a place of vermin, and its germicidal value is inferior to formaldehyde; and, as its poisonous nature is such a serious drawback, it has a very limited place in practical disinfection.

CHAPTER XVI.

SPECIAL PROCESSES.—Continued.

Liquid Disinfection.—Liquid disinfectants are hard to apply to all the surfaces of an ordinary living room, and it is furthermore difficult to hold the solution in contact with the ceiling, walls, and other surfaces a sufficient length of time in order to obtain the certain action of the substance.

Formalin.—Formalin is a very valuable liquid disinfectant and has a wide range of usefulness in general practice. The liquid is superior to bichloride of mercury for many purposes, for its action is not retarded by the presence of albuminous matter. Formalin does not injure most articles. It is a true deodorant also.

Formalin consists of 40% of the gas formaldehyde in water. The liquid is a clear solution, giving off an odor of formaldehyde gas.

Formalin solutions are rather unstable. There is a constant loss by evaporation if the liquid is not kept in well stoppered bottles.

Hot formalin attacks iron and steel, and therefore can not be used for the disinfection of such objects. It does not attack copper, brass, nickel, zinc and other metallic substances.

It causes no diminution in the strength of textile fabrics, and has no bleaching or other deleterious effects

upon colors. Formalin solution renders leather, furs and skins brittle as a result of the union that takes place between the formaldehyde and the organic matter of these articles, and they should therefore be disinfected by another method.

The formalin as found upon the market is acid as a rule, due probably to formic acid. For this reason the solution is apt to spot the delicate colors of silks and fine stuffs. Even water will do this. Such articles should be disinfected with formaldehyde gas.

A 4 % solution of formalin (containing 40% formaldehyde) in water, is also the equivalent of a 1:1,000 solution of bichloride of mercury, or superior to a 5% solution of carbolic acid.

Feces are deodorized instantly by a 4% solution of formalin and are rendered sterile at the end of ten minutes when mixed with an equal volume of a solution of this strength.

Formalin is very useful for the disinfection of urine, excreta, sputum, and other albuminous matters. It combines with, but does not coagulate the albuminous matter and penetrates deeply.

There is a great difference between the antiseptic and the germicidal value of formalin. That is to say, a very minute amount, 1 in 25,000 or 50,000, is sufficient to inhibit the growth and development of bacteria, whereas it requires a 1 to 4 per cent. solution to kill bacteria in a short time. A very minute trace added to milk or wine and other fluids will preserve them for a long time from spoiling. Formalin added to milk makes it indigestible, and its use should not be allowed.

How to Make Solutions.—Rule: *Subtract from the index* (40) *the per cent. desired; and divide the remainder by the per cent. desired.*

The index of a solution is the percentage of purity, and in the case of formalin it has been established as 40. Formalin consists of 40 parts formaldehyde gas and 60 parts water.

Example: Make a 10% solution of formalin:

40 minus 10 equals 30; and divided by 10 equals 3.

The answer equals the parts of water to one part of formalin.

Therefore, by adding 3 parts of water to one part of formalin of 40% strength you will get a ten per cent. solution.

Rule: *Multiply the total solution* (reduced to ounces) *by the per cent. desired, and divide the product by the index. The answer is the ounces of formalin. The total solution, minus the ounces of formalin, equals the ounces of water.*

Example: Make a gallon of a 10% solution.

1 pint	equals	16	ounces.
1 quart	equals	32	ounces.
1 gallon	equals	128	ounces.

The total solution, or one gallon, reduced to ounces is 128.

128 times 10 is 1280; and, divided by 40, is 32, or the ounces of formalin.

The total solution, 128, minus the ounces of formaldehyde, or 32, equals 96, or the ounces of water.

Often it may be the case that the formaldehyde you

may buy would be of a lesser strength than is given before. That is to say, you may buy formaldehyde that is only 25% strength instead of the standard strength, which is 40%.

In this case you will observe the same rules as are heretofore provided, with the exception that the index will be made the same as the strength you have bought.

For example: Make 10% solution from formaldehyde that is only rated at 25%:

25 minus 10 equals 15; and, divided by 10 equals 1.5 or 1½ parts of water to 1 part of this grade of formalin.

Or, according to the other rule: For 1 gallon of 10% formaldehyde from a grade of formaldehyde that is only 25% index, 128 times 10 is 1280; and, divided by 25 is 51.2, or the ounces of this grade of formalin. The total solution, 128, minus the ounces of formalin, or 51.2 equals 76.8, or the ounces of water.

Bichloride of Mercury.—Bichloride of mercury, or mercuric chloride, known commonly as corrosive sublimate, is one of the most powerful and valuable liquid germicides known. In its action, it destroys all forms of germ life in very weak solutions.

The germicidal power of bichloride has been carefully studied in many laboratories, so that we are in possession of definite knowledge as to the exact strength and time necessary to accomplish the disinfection.

A 1:300,000 solution acts as an antiseptic for all forms of germ life.

A 1 : 1,000 solution acts as a germicide and is ample for the destruction of all forms of germ life, at the ordi-

nary temperatures, provided that the exposure is continued not less than one-half hour.

Bichloride is particularly serviceable in a standard solution (1:1,000) for the disinfection of hands and body, not only of the dead body, but the live body as well, and for the disinfection of floors, woodwork, etc.

Its disadvantages are as follows:

(1) It can not be used as a deodorant.

(2) It will corode all metals.

(3) It forms insoluble compounds when brought in contact with albuminous matter; for this reason it is not applicable for the disinfection of feces or sputum, nor can it be used in embalming fluid.

(4) It is a very poisonous compound, and therefore the solution should be colored or marked POISON, to prevent accident.

(5) It is not adapted to aerial disinfection, for it will not produce gas in any form.

How to Make Solutions.—A salt, when intended for liquid solutions, is based on the number of grains of salt to 1 quart of water; accurately, 1 qt. water = 14579.2 grains, but in use we say 1 qt. = 14000 grains.

Rule: The total amount of water is to the total amount of corrosive sublimate as 1 part of water is to 1 part of corrosive sublimate, or,

Total amt. water: total cor. sub. ::% water ;% cor. sub.

or,

$$14579.2 : X :: 1000 : 1$$

$$1000X = 14579.2$$

$$X = 14.6 \text{ grains}$$

Or again, if we want a quart of a 1 : 1000 solution, reduce the total solution (1 qt.) to grains, which would be 14579.2 gr., and divide this by the per cent. desired or 1000, or 14579.2 gr. divided by 1000 equals 14.6 gr.

Therefore if you add 14.6 gr. to one quart of water, you would get a 1:1,000 solution.

Or again, if you want a quart of a 1:2000 solution: Divide the number of grains in one quart by 2000; or, 14579.2 divided by 2000 equals 7.3 gr.

Or again, if you want a gallon of a 1:2000 solution, divide the number of grains in one gallon (4 qts.) by 2000; or, 58316.8 divided by 2000 equals 29.2 grains.

Carbolic Acid.—Carbolic acid is a very good disinfectant and has a very wide range of usefulness. It can not be depended upon to kill spores, for it is not as strong a coagulator as bichloride of mercury. It may be used for the disinfection of bedding and also for excreta sputum and like substances. It is not as trustworthy as some of its by-products for these purposes, such as tricresol and lysol.

Carbolic acid is known as phenic acid, phenyl alcohol and coal tar creosote, and is represented by the chemical formula C_6H_6O. It is produced by the dry distillation of coal and is the chief constituent of the acid portion of coal tar oil. Pure phenol crystalizes in long, colorless needles. The carbolic acid of commerce forms a crystalline mass which usually turns red in time and in contact with moist atmosphere liquidizes into a brown liquid. Carbolic acid has a penetrating odor, a strong, burning taste, and is a corrosive poison.

The carbolic acid of commerce contains impurities,

such as the cresols and the higher by-products, some of which have a higher germicidal power than the pure carbolic acid itself. The commercial product also contains tar oils which are probably lacking in germicidal qualities. The cruder chemical containing these impurities has been shown to be superior to the highest grades of refined acid, which is practically pure phenol.

The acid dissolves in about 15 parts of cold water at the ordinary temperature. In this proportion the saturated solution contains between 6 and 7 per cent. of the acid. It is commonly used in 3 to 5 per cent. solutions, which are entirely trustworthy for the disinfection and destruction of all infectious diseases due to non-spore-bearing microorganisms.

The acid in 5 per cent. solution is not destructive to fabrics, colors, metals or wood, and may therefore be employed for the disinfection of a great variety of objects.

The fact already mentioned, that it does not readily coagulate albuminous substances, renders it particularly applicable to the disinfection of excreta, sputum, urine and the like. Carbolic acid should not be used for the disinfection of tetanus, anthrax, and other diseases due to spore-bearing bacteria.

A 5 per cent. solution of carbolic acid is very useful as a general disinfecting agent, and is especially applicable for sputum and other discharges from the nose and mouth occurring during the process of embalming.

When used for washing the face and hands, a 2½ per-cent. solution should be used.

Carbolic acid acts only by direct contact. It can not be used as an air disinfectant, and spraying the room

or placing it about in open vessels has no effect on germs.

How to Make Solutions.—Rule: *Subtract from the index* (95) *the per cent. desired, and divide the remainder by the per cent. desired.*

The index of a solution is the per cent. of purity, and in the case of carbolic acid it has been established for practical purposes at 95.

Example: Make a 5% solution of carbolic acid.

95 minus 5 equals 90; and, divided by 5, equals 18.

The answer equals the parts of water to one part of carbolic acid.

Therefore by adding 18 parts of water to one part of carbolic acid of 95% strength you will get a 5 per cent. solution.

Rule: *Multiply the total solution* (reduced to ounces) *by the percentage desired, and divide the result by the index. The answer is the ounces of carbolic acid. The total solution minus the ounces of carbolic equals the ounces of water.*

Example: Make one gallon of a 5% solution.

One pint equals 16 ounces.
One quart equals 32 ounces.
One gallon equals 128 ounces.

128 times 5 is 640; and, divided by 95, equals 6 14/19, or the ounces of carbolic.

The total solution 128, minus the ounces of carbolic or 6 14/19 equals 121 5/19, or the ounces of water.

The Cresols.—Tricresol is about three times as powerful a disinfectant, bulk for bulk, as carbolic acid, and a 1% solution is effective for all the ordinary purposes. The

presence of albuminous matter in the substance to be disinfected does not interfere seriously with the germicidal property of this chemical. The tricresol has an advantage over carbolic acid in that it may be depended upon to kill bacterial spores.

In the composition of tricresol we find a mixture of ortho-cresol, meta-cresol and para-cresol. Meta-cresol is a liquid and the other two are solid bodies of a crystaline formation, having a low melting point. These aforementioned cresols are some of the impurities found in the carbolic acid of commerce. The group of cresols are the next higher homologue (chemicals having the same nature) to phenol. You may have trouble putting the cresols into solution, but it can be done with the aid of soaps or by the cresol salts.

The cresols are the accompanying ingredients to phenol and are both found in coal tar. The form of the tricresols is that of a clear or pinkish colored syrupy liquid. About a 2½% solution can be made in water. Its poisonous qualities are somewhat less prominent than carbolic acid, but its uses are the same. It is commonly used in a 1% solution.

There are a number of cresol preparations now being used extensively throughout many hospitals. Harrington gives a list of those considered as trustworthy disinfectants: Creolin, Lysol, Saprol, Solveol, Solutol, Saponate.

Creolin contains 10% of cresols and a small amount of phenol held in solution by soap. It is a dark brown, thick, alkaline liquid, and forms a turbid, whitish emulsion with water. It is considered at least equal, and perhaps superior, to phenol.

Lysol contains about 50% of cresols, with neutral potash soap. It is a brown, oily liquid, and mixes with water in all proportions, and forms a soapy, frothy liquid. It is more powerful than phenol, and ranks with tricresol as a germicide.

Saprol contains 2% of mineral oil and 80 per cent. of crude carbolic acid. It is lighter than water, and when thrown into it diffuses over the surface in a thin layer, which gradually yields its active ingredients to the strata below, so that in the course of a day the water becomes impregnated to the extent of 0.34%. It is superior as a general disinfectant to carbolic acid.

Solveol is a concentrated watery solution of the cresols with sodium cresotinate. It contains over 2½% of cresols. It is non-irritating and much less toxic (poisonous) than carbolic acid. As a disinfectant it is considered the equal if not the superior of any of the cresol preparations.

Solutol is a solution of about 60% cresols in sodium cresols. Those who have used this preparation claim for it superior germicidal powers to creolin, lysol, solveol and phenol.

Saponate is prepared by melting pure soft soap in a dish on a steam bath with an equal quantity of crude carbolic acid. The resulting solution is heated until it remains clear upon cooling and dissolves in distilled water. It is a clear Madeira colored fluid of neutral reaction, and soluble in all proportions of water, alcohol and glycerine. It is said to have a less disagreeable odor than lysol, besides being as satisfactory as the best pure lysol.

Lime.—Lime may be used as a liquid disinfectant in the form of lime water, slaked lime, white-wash and milk

of lime. The lime in almost any of its forms is very caustic, and useful for the destruction of organic matter as well as germ life. It is on account of its efficiency and cheapness that it is a very valuable agent.

(a) *Lime water* in .0074 per cent. solutions destroys typhoid fever germs in a few hours. Lime water in .0264 per cent. solutions destroys cholera germs in a few hours. So with these two examples as illustrations one must know that simple lime water solutions in very weak strengths are very applicable.

(b) *Slaked lime.*—This is calcium hydroxide $CaOH_2$, and is made by taking two pounds of lime and adding one pint of water. The mass becomes heated and the air escapes with a hissing noise. As a disinfectant it is very efficient, and is especially applicable for use in latrines, garbage barrels, etc.

(c) *White-wash.*—This is slaked lime mixed with about four times its volume of water to the consistency of a thick cream. It is useful for the disinfection, sweetening and brightening the walls of cellars, rooms, barns and stables, and in fact all outhouses in general. It is also very useful for the disinfection of excreta and like substances.

(d) *Milk of lime.*—This is the same as white-wash. It can be used as a substitute for chloride of lime, but care should be taken that no air-slaked lime is used. The milk of lime is made from the hydrate of lime (slaked lime) by mixing one part of the dry hydrate of lime with eight parts by weight of water. The dry hydrate is made by mixing six parts of water by weight with ten parts of lime, and should be kept in an air-tight receptacle until used.

(e) *Caustic lime.*—This, too, is the same as whitewash. It should be used fresh. A quart of lime to a gallon of water. It is used for the disinfection of feces and evacuations. In typhoid or cholera, mix equal parts of lime and feces and allow to stand for an hour.

(f) *Chloride of lime.*—This is a gaseous non-poisonous disinfectant. It should be used in the fresh state and brought in direct contact with the infected material. One part to five parts of water is sufficient in strength.

By dissolving six ounces of chloride of lime in one gallon of water, a 4% solution is obtained. Discharges from the bowels, kidneys, throat and lungs of a patient suffering from a contagious or infectious disease should be received in a vessel containing this solution and allowed to stand for an hour or more before being thrown into the vault or latrine. Chloride of lime can be purchased in quantities at a very reasonable sum and is a very reliable disinfectant.

(g) *Air-slaked lime or calcium carbonate.*—When water-slaked lime or calcium hydroxide is exposed to the air it will absorb still more carbon dioxide, and is thus converted into calcium carbonate, which *has no disinfectant properties.* Therefore freshly slaked lime should always be used.

(h) *Liquid chlorinated lime.*—$CaOCl_3$. This is commonly called bleaching powder, in the solid form.

"*American standard.*"—Use 6 ounces of the powder to 1 gallon of water. This solution may be used for the disinfection of discharges and for the scrubbing of floors and woodwork.

"*Chamberland and Fernback Solution.*"—C-

1 part of powder with an equal part of water, and after standing one hour the mixture is filtered and a greenish liquid is obtained. One part of this greenish solution is added to ten parts of water for application to surfaces to be disinfected. It should be applied hot, with the room temperature elevated.

"*United States Army.*"—A 4 per cent. solution of chlorinated lime is used for the disinfection of feces.

Carbol-sulphuric Acid.—This is made of equal parts of crude carbolic acid and concentrated sulphuric acid. Slowly add to the carbolic acid, which should be contained in a vessel that stands in water for the purpose of slacking the development of heat, an equal volume of concentrated sulphuric acid. From the mixture, solutions of from two or three per cent. can be made in water. This solution will be useful for the mechanical forms of disinfection. It has been used with good results in sewers during epidemics of water-borne diseases.

Labarraque's Solution.—Labarrague's solution is an aqueous solution of several chlorine compounds of sodium, chiefly sodium hypochlorite and sodium chloride. The solution is clear and colorless when pure. Its germicidal properties depend upon the liberation of chlorine set free by the decomposition of the sodium hypochlorite. It is more expensive and somewhat less efficient than the solution of chlorinated lime and has no advantages over that substance.

CHAPTER XVII.

SPECIAL PROCESSES.—Continued.

Solid Disinfectants.—Solid disinfectants are of more importance in the sanitation of communities and in the disposition of fecal matter from the intestines of infected living persons than for any other purposes. In the general prophylaxis against disease the disposition of the excreta takes an important position, that of preventing water-borne infection by the initial destruction of the pathogenic microbes within the excreta.

After post-mortem examinations have been held, a solid disinfectant is also valuable for disinfection of the disturbed cavities and their contents.

Magnesium Sulphate.—In specific cases of communicable diseases, where a post-mortem has been held, magnesium sulphate pure, or equal parts magnesium sulphate and sawdust, is recognized as an efficient disinfecting compound when placed in the exposed cavities. In this case it is known principally as a hardening compound, yet the disinfecting properties should not be lost sight of.

In use as a disinfecting compound it should entirely surround the viscera or organs to be disinfected, and should also be placed between the various organs.

Solid disinfectants are the more valuable for this purpose, as they will not fall away from the organs to be disinfected and will not gravitate to the base of the cav-

ity, as would be the case should a liquid compound be used. In all forms of disinfection it is recognized as necessary that the infected material should be brought into actual contact with the disinfecting material.

Granulated Zinc Chloride.—Granulated zinc chloride may also be used as a solid disinfectant in combination with magnesium sulphate, but the addition of the zinc adds but little to the disinfecting power of the compound, makes it more expensive to use, and makes it a poisonous compound such as is made illegal by the laws of the various states pertaining to the use of mineral poisons in and around the dead body.

Lime.—Lime may be made in two ways, first by oxidizing native calcium, as follows:

$$Ca + O = CaO.$$

or by calcining native calcium carbonate ($CaCo_3$) such as chalk, limestone, or marble. Here carbon dioxide is thrown off, and the calcium oxide remains, as follows:

$$CaCO_3 - CO_2 = CaO.$$

Lime is used very commonly for the disinfection of stools coming from typhoid fever patients, tubercular patients, etc. It must be remembered that to have an effective disinfection of these stools, they must be covered with the lime about two times the volume of feces, allowed to stand in the vessel at least an hour before they should be permitted to be thrown into the latrine, cesspool, or sewer. It is best to disinfect the feces, that are considered infectious, before they are thrown into the latrine, so as

not to contaminate the surrounding soil from the latrine or the river water from the sewer.

People commonly use lime to sprinkle about in the latrine, which is a good habit, and one which ought to be more prevalent in the country districts or in the crowded districts where there is no common sewer, (a condition which existed in Baltimore until recently). It must be remembered, though, that *only the lumpy lime is to be used.* The powdered dust which we find in the bottom of the lime houses and which is often used by many, is a form called air slaked lime and has no value as a disinfectant.

Lime was used in the earlier times in connection with the disposal of the dead. The body was surrounded, in a tight coffin, with twice its weight of fresh unslaked lime, without the addition of water or moisture in any form.

It would be well to revive this custom for the disinfection of those bodies that have become so putrid that it is impossible to do arterial or cavity embalming. Such a case would be where a body is found in the woods, or in the water, and has been dead so long that arterial and cavity injections are impossible. In these cases place about three inches of lime in the bottom of the casket, place the body in the casket as carefully as possible, then cover the entire body with the lumpy lime, and bury the body.

CHAPTER XVIII.

ANTISEPTICS.

Antiseptics.—An antiseptic is any drug, chemical or agent which will retard the growth of microorganisms, but may not necessarily destroy them. All true chemical disinfectant agents are still antiseptic when diluted, provided that the dilution is not carried too far (i. e., bichloride of mercury has some trace of antiseptic power even at the enormous dilution of 1:300,000).

We append a list of chemicals giving the minimum strength at which they are classed as antiseptics:

Acetic Acid	1 to 250
Alcohol	1 to 10
Alum	1 to 222
Aluminic Acetate	1 to 6000
Aluminic Chloride	1 to 714
Ammonium Chloride	1 to 9
Ammonium Sulphate	1 to 4
Arsenate Soda	1 to 123
Arsenious Acid	1 to 166
Arsenite Potassium	1 to 8
Benzoic Acid	1 to 909
Boracic Acid	1 to 143
Borax	1 to 114
Camphor	1 to 214
Calcium Chloride	1 to 225
Carbolic Acid	1 to 333

Chloral Hydrate	1 to 107
Chlorine	1 to 4000
Chromic Acid	1 to 5000
Copper Sulphate	1 to 11
Creosote	1 to 200
Ether	1 to 90
Ferrous Sulphate	1 to 18
Formaldehyde (aqueous) (40 per cent.)	1 to 30000
Glycerine	1 to 4
Hydrochloric Acid	1 to 375
Hydrogen Peroxide	1 to 20000
Lead Chloride	1 to 500
Lead Nitrate	1 to 277
Mercury Bichloride	1 to 14300
Mercury Iodide	1 to 40000
Osmic Acid	1 to 6666
Phenol	1 to 333
Potassic Arsenite	1 to 8
Potassic Bichromate	1 to 909
Potassium Nitrate	1 to 160
Potassium Permanganate	1 to 285
Salicylic Acid	1 to 1000
Sodium Bicarbonate	1 to 20
Sodium Chloride	1 to 6
Sodium Hyposulphite	1 to 3
Sulphur Dioxide (Sulphurous Acid)	1 to 2000
Sulphuric Acid	1 to 560
Tannic Acid	1 to 207
Thymol	1 to 1340
Turpentine	not known
Zinc Chloride	1 to 526
Zinc Sulphate	1 to 6

Antiseptics are also used on the hands of the embalmer to protect the skin against invasion of either disease producing or septic (putrefactive) bacteria.

For this purpose the following solutions may be used:

Mercury Bichloride	1:1000 solution
Potassium Permanganate	1 per cent. solution
Lysol	1 per cent. solution
Carbolized Vaseline	2 per cent. carbolic acid

These are considered as standard for this purpose.

Many cases of septicaemia (blood poison) would be prevented by the use of any of these chemicals in the proper strengths. Cases where the body has died from an eruptive communicable disease, such as erysipelas, should never be handled by the embalmer without first anointing the hands with one of the above solutions.

Slight abrasions of the skin, perhaps unnoticed, and in some instances perfectly healthy skin, have been known to allow the passage of a pathogenic (disease producing) microbe into the healthy body. While the possibility of infection after anointing the hands with any of the above solutions is reduced to the smallest possible percentage.

These solutions are especially valuable for those persons who oppose the use of rubber gloves on account of the hindrance to the perfect use of the fingers.

Antiseptics are employed mainly to prevent or arrest decomposition of organic substances. Apart from embalming purposes they are used for the preservation of food, and to prevent or restrain decomposition in organic refuse, or a precaution against rotting of timber and in many ways, especially in surgery.

CHAPTER XIX.

BLOOD SOLVENTS.

Blood Solvents.—A blood solvent is a chemical that will prevent the coagulation of blood or will thin out thickened blood.

The coagulation of blood being caused by the formation and hardening of blood fibrin, a chemical to be a blood solvent must act against the formation of fibrin. Fibrin is an albuminous substance and is coagulated or hardened by bichloride of mercury, formaldehyde, and to the same extent by carbolic acid. Chemicals that are placed in solution with germicides such as formaldehyde and carbolic acid in order to prevent this coagulation, which would naturally occur were germicides used alone, are all called blood solvents.

Under the heading of blood solvents we will find:

Common salt (sodium chloride).
Borax (sodium biborate).
Sodium sulphate.
Boracic acid.
Oxalic acid.

These chemicals, as blood solvents, can be used in solutions ranging from 1 per cent. to 3 per cent. in strength. There are 58,316.8 grains in a gallon of water; to get a 1 per cent. solution it would take 1/100 of 58,316.8, which

would be 583.2 grains or approximately 1¼ ounces of the chemical to each gallon of water. A 2 per cent. solution would then require 2½ ounces, and a 3 per cent. solution would require 3¾ ounces. Should these chemicals be used in embalming fluids, the number of ounces mentioned above for the various strengths would be for each gallon of finished fluid.

Any fluid containing formaldehyde as a base could not be used where blood was to be removed either by drainage or aspiration unless a blood solvent was incorporated into the solution.

Diluting any standard finished fluid to one-half of its normal strength, as far as the first bottle for injection is concerned, adds to the effectiveness of the blood solvents by the extra dilution of the formaldehyde.

For extreme effects in removing blood with the aid of a blood solvent, inject 1 per cent. solution of any of the blood solvents into the circulation before injecting any formaldehyde fluid. For this purpose an amount can be used ranging from one-half to one gallon, depending on the size of the body and the condition of the blood.

After blood has once clotted in the blood vessels of a body, blood solvents are powerless to dissolve them. All suitable precautions should be observed in the first place so as to prevent the coagulation from taking place.

Blood solvents take a prominent part in the procedure against blood discolorations, and Chapter XIV, "Anatomy and Embalming," Nunnamaker-Dhonau, should be referred to for further information as to the practical applications of these solutions.

CHAPTER XX.

BLEACHERS.

Bleachers.—Bleachers are chemicals having the power (1) to restore the body tissues to their normal or natural color; (2) to remove or bleach out the color of any foreign matter which may be in the circulation; (3) to bleach the skin in an effort to remove (a) the color of bile pigments, (b) putrefactive colors, (c) blood staining, especially those due to bruises, etc., (4) to whiten the appearance of the skin by an internal injection.

Bleachers are a necessary part of the modern embalming fluid of which much is demanded from a cosmetic standpoint. Formaldehyde, the base of modern fluids, great as its general power is, presents great faults, among which we find the tendency to make fast or set any color with which it comes in contact.

It is the particular function of bleachers and blood solvents to eradicate this condition as much as possible, that the offending color and its cause be removed or destroyed before the setting action of formaldehyde takes place.

The chemical coming under action (1) in the definition is potassium nitrate (saltpetre.) The average strength at which this chemical is used is from 1 per cent. to 2 per cent. or from 1¼ to 2½ ounces to each gallon of finished fluid.

The chemicals used under action (2) are sodium biborate (borax), oxalic acid, and boracic acid. These chemicals are used principally in the attempt to reduce the yellow color of jaundice and are preferably injected into the circulation in the form of a 1 to 3 per cent. watery solution before the embalming fluid is injected. The injection is made into an artery close to the center of the circulation, and a large vein is opened to allow the accumulated blood and bile pigment to flow from the body. An average betterment of at least 50 per cent. should be expected from this treatment. For a 1 per cent. solution, 1¼ ounces of chemical should be dissolved in 1 gallon of water. For a 2 per cent. solution, 2½ ounces are dissolved. For a 3 per cent. solution, 3¾ ounces are dissolved.

The chemicals coming under action (3) (a) are hydrogen peroxide (full commercial strength) and zinc peroxide, 10 per cent. solution. In this case an active oxidizing agent is wanted so that the organic impurity (biliverdin or bilirubin) may be bleached by oxidation.

The chemicals coming under action (3) (b) are zinc chloride and hydrated choral. Zinc chloride, in combination with other chemicals listed in the following formula has proven successful for the active bleachment of the greenish tinge of putrefaction.

Formula Rx.

Zinc chloride	5 grains
Mercury bichloride	10 grains
Alum	10 grains
Grain Alcohol	4 fl oz.

For hardening add .

Formaldehyde ....2 fl. oz

The chemicals coming under action (3) (c) are acetic acid, 4 per cent. watery solution and sodium sulphate, 6 per cent. watery solution. The chemicals are to be used by subcutaneous (hypodermic) injection into the affected part, after which they cause the disappearance of the blood color. Massaging is imperative to assist the dissolving action. (For the removal of blood discolorations, Chapter XIX of this book and Chapter XIV "Anatomy and Embalming," Nunnamaker-Dhonau, should be consulted.)

The chemicals coming under action (4) are hydrochloric acid, 2 per cent. zinc chloride, 5 per cent. and hydrated chloral, 2 per cent. For this purpose they would necessarily be a part of an embalming fluid, some of which contain one or more of the chemicals. The trend of modern thought is somewhat against the chlorine compounds mentioned above, as the natural paleness resulting from the use of these chemicals is considered an inferior effect.

Extreme bleaching is considered secondary to a good natural life-like appearance.

The following solution is especially valuable for bleaching bones for anatomical study.

Formula Rx.

Chlorinated lime ....10 lbs.
Soda ash ....10 lbs.
Water ....20 gal.

CHAPTER XXI.

INSECTICIDES.

Insecticides.—In our work for the prevention of disease the insecticides should not be overlooked. Just because a chemical is a good disinfectant does not denote that it is a good insecticide. An insecticide is any drug, chemical, or agent *that will absolutely kill insect life.* Many agents have a destructive action upon flies, fleas, mosquitoes, and vermin. Among these may be mentioned:

Arsenic, acetoarsenite of copper (Paris green), arsenite of copper (Scheeles green), bisulphide of carbon, hydrocyanic acid gas, petroleum, pyrethrum, sulphurous acid gas.

As the fly, mosquito, flea, and other insects are known or suspected of conveying the infection of some of the communicable diseases, it is important that the disinfector know how best to destroy this class of vermin. The general subject of protecting the individual against the bites, dangers, annoyances, of flies, mosquitoes, etc., and the subject of ridding a community of these dangerous vermin, is a very important one from an economic and hygienic standpoint, and is discussed under the particular disease of which they form a part. At this time, however, only those agents are considered which are useful to the disinfector in exterminating vermin, in a room, or building in order to prevent the spread of the disease.

The mosquito is known to transmit the infection of several diseases. This insect is the intermediate host for the parasites of malaria, yellow fever and filariasis. The microorganisms are taken into the stomach of the mosquito with the blood it sucks. From the stomach the parasites pass into the general body cavity, or the glands of the mosquito, and are extruded again through the insect's proboscis under the skin of its victim. That is to say, that the mosquito inoculates the infectious principles into the system just as we would experimentally inoculate an animal by means of a hypodermic syringe.

On the contrary, the fly, ant, flea, and other insects, transmit the infection of disease in quite another way. For instance, flies spread the infection of typhoid fever, cholera, plague, and anthrax by having the infection smeared upon their legs and upon the external surfaces of their bodies. This is readily understood when we recall the habit of flies feeding upon and breeding in the decomposed meats, dejecta, and other matters apt to contain the infectious principles of the above named diseases.

The investigation of the Army Medical Commission during the Spanish-American war practically established the fact that the fly is an important factor in the dissemination of typhoid fever. Victor Vaughan, a member of that commission, stated that flies undoubtedly served as carriers of typhoid infection, giving the following reasons for his belief: "They swarmed over fecal matter in the latrines. They visited and fed on food prepared for the soldiers in the mess tents. In some instances, when lime had been recently sprinkled over the contents of the

latrines, flies with their feet whitened with lime were seen walking over the food. Officers, whose tents were protected by means of screens, suffered less proportionately from typhoid fever than those whose tents were not so protected. Typhoid fever gradually disappeared in the fall of 1898 with the approach of cold weather and the consequent disabling of the fly.''

It is perfectly easy to understand how a fly, alighting upon the skin of a smallpox patient, and contaminating its legs, proboscis and body with the fluid exudates from the vesicles and pustules, may carry this highly infectious material to other persons in the same house or to neighboring houses.

Flies, fleas, ants, and other insects spread the infectious principles of many communicable diseases in another way than simply this mechanical conveyance of the bacteria upon their external parts. These insects feed upon organic matter containing the infective principles, which live a variable length of time in the intestinal tract, and the live and virulent microorganisms are deposited with the dejecta. In this way infection is transmitted from infected materials to man, from animals to man, and from man to man.

It is believed that the biting insects, such as flies, fleas, ants, etc., do not inoculate the parasites under the skin when they bite. When this does occur, it is probably due to an accidental contamination of the mouth or biting parts of the insect with the infective germs. In other words, the transference seems to be mechanical. The insect does not act as an intermediate host, and the bacteria do not pass through the various phases of de-

velopment in the insect, as is the case with the malarial parasite and mosquito.

The flies, fleas, ants, etc., deposit the infectious material on the skin with their excrement, and in other ways. The virulent infection is rubbed into the little wounds or scratched into the skin as a result of the irritation caused by the bites, thereby setting up the disease.

For the reason that plague is transmitted through the agency of rats, a paragraph is introduced upon the means commonly employed to destroy these rodents.

Arsenic.—The arsenical compounds, according to Marlatt, have supplanted practically all other substances as a food poison for biting insects. The two arsenicals in most common use and obtainable everywhere are Paris green and London purple. Scheele's green and arsenite of copper are less known and less easily obtainable, but in some respects are better than the first named poisons, as will be shown later. The use of powdered white arsenic is not recommended on account of its corrosive action as well as the fact that it is apt to be mistaken for harmless substances.

Paris green is a definite chemical compound of arsenic, copper and acetic acid (known as aceto-arsenite of copper), and should have a nearly uniform composition. It is a rather coarse powder, or, more properly speaking, crystal, and settles rapidly in water, which is its greatest fault so far as the making of suspensions of this substance is concerned. The cost of Paris green is about 20 cents per pound.

Scheele's green is similar to Paris green in color and differs from it only in lacking acetic acid, in other words,

it is simply arsenite of copper. It is a finer powder than Paris green and therefore is more easily kept in suspension, and has the additional advantage of costing only half as much per pound.

London purple is a waste product in the manufacture of aniline dyes, and contains a number of substances, chief among which are arsenic and lime. It is quite variable in the amount of arsenic it contains and therefore is not so effective as the green poisons. It comes in a fine powder and is more easily kept in suspension than Paris green. It costs about 10 cents per pound.

Arsenite of lead is prepared by compounding approximately 3 parts of arsenite of soda with 7 parts of acetate of lead (white sugar of lead) in water. These substances when pulverized, unite readily and form a white precipitate, which is more easily suspended in water than any of the arsenical compounds. Bought wholesale the acetate of lead costs about 7½ cents per pound, and the arsenite of soda about 7 cents per pound. Its use is advised where excessive strengths are desirable and upon delicate plants where otherwise scalding is likely to result.

The arsenical compounds may be applied in one of three ways: (1) in suspension, as poisoned waters mainly in the form of sprays; (2) as a dry powder blown or dusted about the infected areas; (3) or as a poisoned bait.

It must be remembered that the arsenicals are very poisonous, and should be so labeled, and care taken to prevent accidents.

An average of one pound of either Paris green, Scheele's green, or London purple to 150 gallons of water

is a good strength for general purposes in using the wet method. The powder should first be made up into a thin paste in a small quantity of water, and if the suspension is to be used upon plants, vegetables, or about foliage, an equal amount of quicklime should be added to take up the free arsenic and remove or lessen the danger of scalding.

For the distribution of dry poison the arsenicals are diluted with 10 parts of flour, lime, or dry gypsum.

Bisulphide of Carbon.—Bisulphide of carbon is a very efficient insecticide, but a dangerous one on account of its inflammable and explosive nature. When pure it is a mobile, colorous liquid, with an agreeable ethereal odor. But often it has a more or less fetid odor from the presence of other volatile compounds. The liquid must be kept in well stoppered bottles, in a cool place away from the light and fire. It evaporates very rapidly at the room temperature, so that in using this substance in a confined place it is sufficient to pour it into open vessels, and it will quickly pass into the air as a gas, in which state it is an efficient insecticide. It is very inflammable, more so than ether, and burns with a pale blue flame, yielding sulphur dioxide and carbon dioxide or monoxide.

Upon the authority of Howard and Marlatt this substance distributed about the pantry or room in open vessels will evaporate, and if used in proper quantities will destroy roaches and other vermin. Unless the room can be very tightly sealed, however, the vapors disappear so rapidly that its effect will be lost before the roaches are killed.

In the use of this substance, every precaution must be

taken to see that there is no fire, lighted cigar, etc., in or about the premises during the treatment, on account of its inflammable and explosive nature. It is also deadly to the higher animals, so that apartments should be thoroughly aired after its use.

According to Hinds, shallow tin pans or plates make good evaporating dishes for carbon bisulphide. The larger the evaporating area the better. There should be about one square foot of evaporating surface to every twenty-five square feet of floor space, and each square foot of evaporating surface should receive from one-half to one pound of liquid. These figures are only suggestive and approximate. Pans should be placed as high in the room as possible, since the vapor is so heavy that it settles most heavily to the lower parts. Care should be taken, when placing the pans, to see that they are nearly level, so as to hold the liquid, though ordinarily no particular harm is done if some of it is spilled. It should not be found necessary to lose time in adjusting such things after the application is begun.

If there are special places which are difficult of access or treatment with pans, cotton waste, bundles of rags, or the like may be saturated with and thrown into the places.

Everything should be done to avoid unnecessary delays and to facilitate the rapid exposure of the liquid. If the liquid is bought in large quantities, smaller receptacles may be provided for transferring it to the pans.

Hydrocyanic Acid.—Hydrocyanic acid is extremely poisonous to all forms of life, killing roaches, bed bugs, mosquitoes, fleas, flies, rats and mice with great certainty

and very quickly. It is much less poisonous to the vegetable forms of life. (See page 170). The gas is much used in greenhouses for the destruction of insect pests, and for the scale insects and other parasites of the fruit trees.

Hydrocyanic acid has a distinct place in the disinfection of granaries, stables, ships, barns, outhouses, and other uninhabited structures infested with vermin. But it should not be used in the household, or any other inhabited building, as the least carelessness with it would probably mean the loss of human life. (See page 170 for its action as a disinfectant).

Petroleum.—Petroleum, kerosene or coal oil is a very valuable insecticide, but of limited application, as it must be used in the liquid form, its vapor being too inflammable for consideration in this connection.

As a remedy for mosquitoes kerosene has proved very effective when applied as recommended by L. O. Howard. He recommends a light grade of fuel oil, and applied at the rate of 1 ounce to 15 square feet of water surface. It forms a uniform film over the surface and destroys all forms of aquatic insect life, including the larvae of the mosquito and the adult females coming to the water to lay their eggs. The oil must be renewed every few weeks, depending upon the temperature and other circumstances.

It is employed to kill the larvae of the mosquitoes in pools, still ponds, stagnant water, water buckets, and other small collections of water not of value for their fish. In large bodies of water it is not nearly so effective, as the oil is blown about by the wind, thereby uncovering the greater part of the surface. An apparatus

devised by Dr. Doty is of use in distributing the petroleum over the surface of ponds. It consists of a wooden framework carrying the oil pipes which deliver the petroleum through many small openings projecting six inches or so below the surface of the water. The float is drawn over the pool while the petroleum is allowed to escape, thus coating the entire surface, and emulsifying some of the oil with the water, which intensifies its insecticidal action.

Petroleum is also useful against roaches, bed bugs, and other forms of vermin when used by direct application or by spraying either in the form of pure oil or as emulsion with water, soap, or milk.

Pyrethrum.—Pyrethrum is a popular and much used insecticide because it is comparatively cheap and non-poisonous to the higher organisms, but unfortunately it is not very powerful for the destruction of roaches, ants, mosquitoes, bed bugs, fleas, flies, etc.

Pyrethrum, also sold under the trade name Buhack and Persian insect powder, is the flowers of the chrysanthemum roseum and the chrysanthemum careneum, both hardy perennials and resembling chamomile in appearance.

According to Kalbrunner, 4 grains of the pure powder sprinkled on a fly in a vial should stupefy it in one minute and kill it in two to three minutes. This is used as a test for the strength of pyrethrum.

It acts on insects externally through their breathing pores, and according to Marlatt, is fatal to many forms of biting and sucking insects, being chiefly valuable against household pests, such as roaches, flies and ants.

It is used either as a dry powder or by its burning fumes. As a dry powder it may be used pure or mixed with flour, in which form it should be puffed about the room, especially into the cracks. Against mosquitoes the powder should be burned in the room, and if used in sufficient strength, it will kill many of these insects, but it can not be depended upon for the destruction of mosquitoes, infected with yellow fever, for some of the insects are only stupefied. They must be gathered up and destroyed after the fumigation.

The regulations of the United States army require the burning of five pounds of pyrethrum for each 1,000 cu. ft. of air space, for the destruction of mosquitoes in confined places.

Sulphur.—Sulphur is one of the most valuable insecticides we possess. It may be used in the following forms:

Sulphurous acid gas, produced and used according to the methods given for bacterial disinfection (page 165), will kill roaches, bed bugs, flies and all kinds of vermin, including rats and mice. This substance, therefore, is exceedingly useful in disinfecting in such diseases as plague, yellow fever, malaria and insect-borne infections. The time of exposure necessary to kill insects and vermin is shorter than that given for sulphur dioxide as a germicide. One hour is ample for mosquitoes, and two hours for rats.

Very dilute atmospheres of the gas will quickly kill mosquitoes. It is very efficacious for this purpose when dry as when moist, whereas the dry gas has practically no power against bacteria. Contrary to formaldehyde, it has surprising powers of penetration through clothes

and fabrics, killing the mosquitoes even when hidden beneath eight layers of toweling, in one hour's time, and with very dilute proportions. This substance, so long disparaged as a disinfectant because it fails to kill spores, must now be considered as holding the first rank in disinfection against insect-borne diseases.

Sulphurous acid gas prepared according to the methods given on page 165 is probably the best insecticide of the sulphur group. Its action is more penetrating, and is successful in the rapid destruction of all vermin and insects.

The *flowers of sulphur* is very efficient in its powdered form as an insecticide. It may be applied in several forms, the simplest of which is to merely sprinkle the dry sulphur about the places where the insects are found. The flowers of sulphur may also be advantageously combined with other insecticides, such as kerosene emulsion, resin wash, or a soap wash, mixing it first into a paste and then adding it to the spray tank in the proportion of 1 to 2 pounds to 50 gallons.

The sulphur in its dry form must be directly applied to the places where the insects are found, and is thus used more for the destruction of the mites and rust of plants and fruit. It has but a limited use against bed bugs, ants, roaches, etc., and is practically useless against the winged insects.

Bisulphide of lime is a good liquid insecticide where a liquid is applicable. It may be very cheaply prepared by boiling together for an hour or more in a small quantity of water, equal parts of flowers of sulphur and stone lime. A convenient quantity is prepared by taking 5

pounds of sulphur and 5 pounds of lime, and boiling in 3 or 4 gallons of water until the ingredients combine, forming a brownish liquid. This may be diluted to make 100 gallons of spray.

Formaldehyde Gas.—Formaldehyde gas, while holding the front rank as a germicide, is a feeble insecticide. It seems to have no effect whatever upon roaches, bedbugs, and insects of this class, even after prolonged exposure to very high percentages of the gas. While very irritating, this substance is not toxic for the higher forms of animal life.

Mosquitoes may live in a very weak atmosphere of the gas over night. It will kill them, however, if it is brought in direct contact in the strength and time prescribed for the bacterial disinfection. For this purpose any of the accepted methods for evolving the gas is applicable, but the methods which liberate a large volume of the gas in a short time are more certain than the slower ones.

Direct contact between the insects and the gas is much more difficult to obtain in ordinary room disinfection against mosquitoes than against germs, because the sense of self-protection helps the former to escape from the effects of the irritating gas. They hide in the folds of towels, bedding, clothing, hangings, fabrics and out-of-the-way places where the formaldehyde gas does not penetrate in sufficient strength to kill them. The gas is polymerized and deposited as paraform in the meshes of the fabrics, which prevents its penetration, and large quantities are lost by being absorbed by the organic matter of the fabrics, especially woolens. In our tests, whenever the insects were given favorable hiding-places, such

as in crumpled paper or in toweling, they quickly took advantage of the best place for themselves and often escaped destruction.

There is a striking analogy between the strength of the gas and the time of exposure necessary to penetrate the fabrics in order to kill mosquitoes, and the strength and the time necessary to penetrate in order to kill the spores of bacteria.

Mosquitoes have a very lively instinct in finding cracks and chinks where fresh air may be entering the room or where the gas is so diluted that they escape destruction. They are able to escape through incredibly small openings. Some of the smaller varieties such as the stegomia fasciata can get through a wire screen having twelve meshes to the inch. Therefore, formaldehyde gas can not be trusted to kill all the mosquitoes in the room which can not be tightly sealed.

It is concluded that to succeed in killing all the mosquitoes in a closed space with formaldehyde gas, the following definite requirements are essential. A very large volume of the gas must be liberated quickly, so that it may diffuse to all parts of the space in sufficient concentration. The room must have all the cracks and chinks where the insect may breathe the fresh air carefully sealed by pasting strips of paper over them. The room must not contain heavy folds of drapery, clothing, bedding, or fabrics in heaps or so disposed that the insects may hide away from the full effects of the gas.

The Destruction of Rats on account of the Plague.—The ordinary methods of catching rats by such means as

cats, dogs, ferrets, traps, poisoned bait, etc., are all useful in ridding a community of this rodent.

In Glasgow, Japan, and other places where plague prevailed as an epidemic, thousands of rats, many of them infected with plague, were caught and disposed of by the authorities offering a price for the heads. Experience has shown that this reward must not be too large, else persons will breed the rodents as a paying investment.

While the extermination of the rats in a city or a community of considerable size may be a hopeless undertaking, their destruction on board a ship, in a stable, granary, or other limited area, is quite possible, although it takes time, care and much patience.

The handling and the final disposition of rats suffering with or dead with the plague, is a matter requiring special care in order to guard against the infection. According to Simond, the fleas transmit the infection from the rats to man. He states that the flea will not leave the rat for man as long as the body of the rat is warm. Therefore, in the handling of rats, whether dead or alive, the hands should be protected with gloves and other precautions taken to guard against the fleas.

The bodies of dead rats should be cremated at once, and all surfaces exposed to the infection disinfected with a bichloride solution or carbolic acid.

The rats on board a ship or in a confined place may best be destroyed by sulphur fumigation. Careful search must be made for the dead bodies. This same substance is useful in destroying or in driving out the rats from a sewer, in fighting the infection of plague in a community.

For this purpose the sulphur is burned in a sulphur furnace and the fumes are driven into the sewer by a centrifugal fan.

Rats may also be killed in a confined place by the use of other poisonous gases, such as hydrocyanic acid gas, carbon bisulphide, or even carbon dioxide. Formaldehyde gas can not be trusted to destroy these rodents.

The carbon dioxide is evolved by simply burning charcoal in open fires and taking care to close the room or hold of the vessel very tightly.

The substance known as Danyz's virus is sometimes useful in helping to rid a locality of these rodents, but it is far from being a sure means in the fight against rats.

Insecticides and Their Uses around the Dead Body.— Insecticides are frequently of the utmost importance in combating the work of the blow fly or other insect on or in the body. From the work of the blow fly, maggots result, which if not killed, will destroy the entire body in a few days.

The ordinary embalming fluids are not insecticides and will not serve to kill these insects or their causes. Mineral oils such as petroleum, benzine, gasoline and naphtha are standard agents for the destruction of insects around the dead body.

The action of these oils is swift and decisive and insect life is not possible in their presence. The oils above mentioned are sprayed on or in any affected part, and where the maggots may be seen coming from any orifice, the oil is injected directly into that orifice.

CHAPTER XXII.

DEODORANTS.

Deodorants.—A deodorant is any drug, chemical or agent having the power of destroying or masking odor. A deodorant may not destroy the germs that cause the odor, or may not even arrest their development. Deodorants are of two kinds, true and false.

A true deodorant is one that acts chemically with the cause of the odor and destroys the odor by killing the cause. An example of a true deodorant would be formaldehyde.

A false deodorant is one that merely covers up another odor with a more characteristic one of its own. Examples of false deodorants are flowers, perfumes, etc.

Among aerial deodorants nitrous acid is one of the most powerful. Chlorine and the fumes given off by moist chloride of lime are also potent, and act by oxidation of organic matter. They decompose sulphurated hydrogen, which is an important constituent of the gases of putrefaction. Hydrochloric acid fumes, like chlorine, neutralize the free ammonia and ammonium carbonate. Sulphurous acid may perhaps act in some degree as a reducing agent and also as an antiseptic, but its chief effect is to overpower the effluvia and necessitate free ventilation. Fumes of wood, tar or paper are quite useless except for the same reason.

Of the solid or liquid deodorants, ferrous sulphate and copper sulphate act mainly by removing the sulphuretted hydrogen as a precipitate; potassium permanganate simply oxidizes; carbolic acid and the essential oils exert an antiseptic effect and so check further decomposition, while at the same time their powerful odor masks all others. The ozone and the peroxide of hydrogen which is believed to be associated with the essential oils may effect a small amount of oxidation.

Formalin.—Formalin is a true deodorant. It does not mask one odor with another, but unites with the albuminous matter to form new compounds that are both odorless and sterile.

Formalin also readily unites with the nitrogenous products of decay, fermentation and decomposition, forming new chemical compounds that are odorless.

Chlorinated Lime.—This substance as a deodorant depends not only on its destructive influence upon organic matter and its germicidal properties, but also upon its great affinity for water, thus acting as a dessicant. It also has the power of combining with hydrogen sulphide and the volatile ammoniacal compounds of decomposition and decay. For this purpose it should be used in the dry form. Chlorine is the chief active constituent. Use in strengths of from 2 to 5 per cent.

Copper and Iron Sulphate.—Disinfectants and deodorizers are recommended for the suppression of offensive odors from privy vaults or latrines, cesspools, feces, etc.

For this purpose use 4 pounds of the salt to 6 quarts of water, for every cubic yard of matter.

It must be said, however, that they will destroy bad odors only to a certain degree, but at that they are better deodorants than disinfectants.

Potassium Permanganate.—As a deodorant use four ounces of the salt to a gallon of water, for every cubic yard of matter.

Platt's Chlorides.—A liquid chlorine compound formed by combining:

Aluminum sulphate,	170	parts
Zinc chloride,	40	"
Sodium chloride,	55	"
Calcium chloride,	85	"
Water,	1,000	"

This compound is sold by all druggists and is extremely valuable in deodorizing sick-rooms, etc. The active deodorizing agent is chlorine gas. In the deodorization of rooms where a death has occurred this compound will be preferable to formaldehyde fumes, since the compound has little or no odor. It can be used by saturating a cloth and hanging the cloth on some convenient object in the center of the room.

After a body is embalmed and placed in the casket in the proper manner, there should never arise any occasion where a deodorizer should be used, yet if something should occur to warrant the use of one, Platt's chlorides sprayed on the underclothing of the body, will be found valuable.

Dry Earth.—Dry earth promotes desiccation of excreta, thus preventing putrefactive changes while absorbing the odors. It has no inherent germicidal or antiseptic properties, but is a useful means of disposing of dejecta in camps and country places where lime and other chemicals are not at hand. Earth, then, is to be only considered as a deodorant.

Charcoal.—Charcoal will absorb the malodorous gases arising from putrefying and fermenting materials, but it is inert so far as its power to destroy the cause of these processes is concerned.

Ashes.—Ashes, also, are to be considered as a deodorant for dejecta and other materials. In actual practice it is used in latrines for deodorizing fecal matter. It is not quite as good as clay or loam for this purpose, but is better than sand or gravel. It also has slight antiseptic and germicidal properties because of the mineral acids found.

CHAPTER XXIII.

EMBALMING FLUIDS.

Embalming Fluids.—Embalming fluids are to the embalmer what drugs and medicines are to the physician. Heretofore this subject has been neglected for various reasons, chief among which was the usual author's relation to some commercial enterprise, closely followed by the apparent apathy of students and practitioners to this important subject. It is difficult to understand why the men who have used embalming fluid in the past were not more interested in knowing the chemical ingredients usually found in fluids and in studying their actions. It is the profound belief of the authors that nothing certain can be accomplished by using an embalming fluid with which the practitioner is not familiar, especially as to its actions and strength. It has been the practice in the past for some practitioners to try each and every concoction on the market, jumping from pillar to post, and never being certain as to just how the fluid is going to act after it permeates the systemic circulation. This should not be construed as to mean that the practitioner should be satisfied with one brand of manufactured fluid to the exclusion of all others. Our meaning is far from that. Any solution manufactured for use as an embalming fluid which contains a germicide of proper strength, fortified by antiseptic salts, should be valuable as a pre-

servative agent. Unless this fluid be watched and studied, however, especially as to its actions in and around all classes of bodies, and the proper amount of the solution is used for each individual case, there will likely be times when bad results will come.

Bad Results with Embalming Fluids.—In times like this the practitioner should carefully review his treatment for—

(1) Correctness of the amount of fluid injected.

(2) Correctness of the circulation obtained.

(3) The possibility of neutralization of the preservative action of the fluid within the body by the elements of an opposite nature.

(4) Correctness of the strength of fluid used.

We have observed a varied action of any given fluid in the presence of the following conditions:

(1) Injection made before the setting in of natural rigor mortis in which the body tissues were alkaline in reaction.

(2) Injection made during or after the setting in of natural rigor mortis in which the body tissues were acid in reaction.

Most modern embalming fluids are alkaline in reaction and are best suited in normal strengths for use before rigor mortis begins in the body. To this fact is due the difficulty one has of securing preservation in cases where putrefactive changes have appeared in the body. Putrefactive changes follow rigor mortis, the coming on of which changes the body from an alkaline to an acid reaction.

It is only logical to believe that an embalming fluid of the same nature as the body would work more efficiently with the conditions within the body than a fluid of an opposite nature.

These contentions are partly proven by the varied actions of any fluid of standard formula in which one effect is obtained in one case and another is obtained in the following case.

The practitioner is often puzzled by the inability of the fluid to bring the firmness to the tissues that usually characterizes the action of the fluid he uses. This is not the fault of the fluid, excepting that it is not suited exactly for the condition within the body, which is of an acid reaction instead of the alkaline reaction usually met with in bodies dead only a short time.

In the case of a formaldehyde fluid, it appears that the coagulable matter in the tissues, the coagulation of which is described as rigor mortis, having been once coagulated and then released by the liberation of free acids in the body, does not readily respond to a normal injection. Preservation itself may be established regardless of this fact, but as many practitioners feel that they must see and feel evidences of hardening they are frequently bothered by its absence.

At the present time all we can recommend in case the tissues do not respond to the hardening properties of the fluid, is to use a stronger concentration for the last part of the injection.

In advising this it is not our wish to be quoted as favoring the hardening of a body, as any treatment looking forward to a hardening effect must needs detract from

the life-like appearance so well thought of by the public whom we must please.

Ideal Condition of Body.—The ideal condition in which to place the body is one in which the under tissues of the body are firm and the skin of the exposed parts is as soft as can be made. With this condition in effect the beautifying of the face is most simple.

The first step to be taken in the use of an embalming fluid is to use a 50% diluted solution for the first injection, to be followed by a more normal finished fluid.

This, as you will see, requires the weakening of the fluid 50% for the first injection. Many practitioners are of the opinion that this will be detrimental rather than beneficial. This, however, is not so, as it has been proven many times that the weaker the fluid used the more can be placed in the circulation and the better the general distribution will be. In other words, it may be stated in speaking of formaldehyde fluids, that a solution containing 2½% formaldehyde will penetrate at least 50% further into the general capillary network than a normal fluid containing 5% formaldehyde, and as the foundation of all preservative treatments is the importance of bringing the tissues to be disinfected and preserved into actual contact with the preserving and disinfecting solution, it would appear that this dilution would be beneficial rather than detrimental.

The Problem of the Circulation.—The problem of obtaining a circulation is much more difficult since formaldehyde is the base of many fluids. When arsenic was the base, the securing of a circulation was more simple. Other

bases in use at this time are creosote and carbolic acid, neither of which present circulation problems such as is presented by formaldehyde. Not only does formaldehyde contract the capillary systems, but in excessive strengths coagulates the blood, especially if attended by an insufficient amount of blood solvent material in the fluids.

Material that will aid in preventing the darkening of the blood in the body is also essential, and these come under the head of bleachers. For a complete list of bleachers and blood solvents Chapters XIX and XX should be consulted.

So far we have mentioned germicides, antiseptics, blood solvents and bleachers. The chemicals having these actions, if properly compounded, should give the very best results, providing a sufficient quantity of the fluid is used and the proper strength of solution is used.

Dry, Medium and Moist Tissues.—We mention the term proper strengths for this reason: there are three classes of bodies with which we come in contact:

(1) Those presenting a dry condition of the tissues—i. e., tubercular and anemic cases, old age, senility, etc. For these cases the finished fluid should be diluted at least one-half for the first bottle and one-fourth for all subsequent bottles. This dilution is advised on account of the previous dryness of the tissues discounting most of the chance for intravascular dilution of the fluid, and the efficiency of the fluid being unimpaired to a large degree.

(2) Bodies dead of non-exhausting diseases, such as pneumonia, cerebral hemorrhage, death by accident where no loss of blood has occurred, etc. The requirements in these cases are the use of a 50% diluted fluid for the

first part of the injection, followed by the normal fluid for the second, third and fourth parts of the injection—i. e., if an arterial injection of one gallon is used, the first quart should be half strength and the following three quarts full strength finished fluid; other quantities in proportion.

(3) Bodies dead of kidney diseases, drowning, etc., in which the capillaries are filled with liquids and the tissues can be said to be saturated. In cases of this character the aim of the embalmer should be to inject one bottle of normal finished fluid and to follow that with a strengthened solution until preservation is assured. The strengthening can be at least one-fourth over normal, and in these days of concentrated fluid this manipulation of the strength of your fluid presents no difficulties.

In cases of this kind there is apt to be an intravascular dilution of the fluid which would reduce the strength of the fluid within the body until without the strengthening beforehand the fluid would be far below the efficient point.

Amount of Fluid to Inject.—In all cases it must be remembered that the amount of fluid used in a body should bear a fairly close relation to the capacity of the blood vessels. Using 1/13 of the body weight as a basis for calculating the capacity of the blood vessels you can estimate the amount of fluid for injection at 75% of the capacity of the blood vessels or in case of a body weighing 130 lbs., 7½ lbs. or pints of fluid.

This is figured in this way in practice:—if the body weighs approximately 130 lbs., 1/13 of the weight would represent the capacity of the blood vessels, and 75% of

that would be the amount of fluid that should be injected, which in this case is 7½ pints or pounds.

The amount of fluid to be injected into the cavities depends on the condition of the organs. In some bodies it may not be necessary to inject the cavities at all while in others an amount equal to the amount of fluid injected in the arteries would be necessary. It will be wise, however, to inject at least ½ gallon of fluid into the cavities, should any cavity injection be necessary. In cases of children this quantity may be altered to suit the size of the body.

When drainage is to be made from the veins, a certain percentage of the fluid will find its way into the blood bottle. This makes it advisable to add to your injection, so that enough fluid be left in the body to maintain a pressure and to insure uniform preservation.

It is not possible for one to set definite figures as to the amount of fluid for the injection, as each case presents peculiarities which must be met. Any form of injection, however, based on the filling of the circulation and the creation of a fluid pressure within the body would be satisfactory.

Disinfection by Embalming Processes.—In addition to the arterial injection, the cavities which contain the viscera can be treated by a hollow needle injection. This provides for the disinfection of any infected organ or part of an organ by external contact with the fluid, and in some cases, such as the stomach or intestines, by the injection of fluid into the cavities of the various organs. The use of the fluid with the hollow needle is a valuable addition to arterial injection.

In the absence of carbolic acid solutions or bichloride of mercury, the body dead of a communicable disease can be washed and disinfected externally by the use of 50% diluted fluid.

Fluid Formulae.—We believe that regularly constituted laboratories, as against the embalmer, are better able to compound fluids with greater accuracy and more uniform strength of chemicals. Under these circumstances we recommend the use of any generally sold fluid, subject to the recommendations described in the fore part of this chapter.

Should you need fluid at any time for emergency use, several formulas are appended, together with directions for compounding them.

The Hygienic Laboratory Formula, according to Past Assistant Surgeon Edward Francis, U. S. Public Health and Marine Hospital Service:

Rx. Solution of Formaldehyde U. S. P......... 1 quart.
Sodium borate U. S. P..................12 ounces.
Phenolphthalein (8% alcoholic solution).. 1 ounce.
Water, a sufficient quantity to make...... 7 quarts.

Directions for making (by Dr. Francis).—Dissolve the borax in boiling water, using about 2 quarts of water for this purpose, and then dilute the resulting solution with about 2 quarts of cold water. Then add the required amount of solution of formaldehyde U. S. P., and the phenolphthalein solution. Dilute to the required volume (7 quarts) by adding water, and mix well. Keep in stoppered containers.

A Standard Formula:

Rx. Solution of formaldehyde U. S. P., 1 quart.
Sodium biborate U. S. P., 12 ounces.
Water in sufficient quantity to make 8 quarts.

Directions for making: Refer to directions given for the Hygienic Laboratory formula.

The foregoing formulae are simple in character, yet sufficient in action to give all of the effects needed for any case, provided the fluids are used in accordance with the recommendations given in the fore part of this chapter. Formaldehyde is present in each to a percentage of 5% absolute formaldehyde in the standard formula and 5.66% in the Hygienic Laboratory formula.

Mineral Poisons in Embalming Fluids.—Mineral poisons are prohibited in the manufacture of embalming fluids for distribution through many states. This legislation is due to the inability to determine the correct medico-legal aspect of a murder or suicide case that has been prepared with a fluid containing either mercury, arsenic or zinc.

It is only timely that the embalmer should know the ways of determining the presence of these chemicals; therefore a complete procedure for analysis of a fluid is incorporated in this chapter.

We have also included tests for carbolic acid, creosote and formaldehyde, for no other reason than to enable you to study the fluid question intelligently.

Carbolic acid and creosote solutions in use as embalming fluids will have a tendency to darken the skin should they be used in excessive strengths. Knowing that a

given fluid contains either of these chemicals, you can use the fluid cautiously and avoid these complications.

General Instructions for Getting Ready for the Work of Analyzing your Fluid.—You will need a few *test tubes* and these can be obtained from your druggist at a very small cost. These are made of glass, and should be preferably about 6 inches in length. I believe it would be advisable to call your attention to the fact that these tubes, being made of glass, should be handled very carefully, so that the breakage is kept down to the minimum.

We use a great many of these tubes in the chemical laboratory for the use of the students in testing out fluids and in analytical work, and as a rule find that the breakage will not amount to more than two or three tubes a year. This would not be the case if we did not caution the student about the matter. You can learn to handle these tubes with care and to lay them down when finished with them so that you will not break them.

The only paraphernalia necessary will be some form of providing heat, so that the liquid in the test tube may be heated. This heating of the mixed solution in the test tube results in quicker reaction and more perfect results in every case.

The usual method of heating the lower end of the test tube is to hold it over the flame of a bunsen burner (which can be obtained from any gasfitter), or an alcohol flame, or any other flame that may be handy.

In holding the test tube containing the solution over the flame always remember to turn the tube all the time, and to move it back and forth through the flame. The object of turning the tube is to obtain as much as possible

an even distribution of the heat, so that the danger of breaking the tube by expansion is removed entirely. The upper end of the tube will never get hot under this method and you will always have complete control over the tube without danger of burning your hands in any way.

When you have decided the question as to what particular chemical you are to test for, place a few drops of the fluid in the test tube and add a few drops of water, and then you are ready for the reagents. Now, the reagents are solutions of chemicals having the functions of throwing different chemicals out of solution, or, in other words, of precipitating the solid elements and of disclosing the presence of different chemicals through precipitation, producing colors, etc.

In the minute instructions for the discovery of each chemical, the proper reagents will be found for each, and now we will go on to the technique of the work after the preparation of the liquid for the reagents.

Place a few drops of the proper reagents in the test tube along with the fluid and the water, and then slowly begin to bring the lower end of the tube into contact with the heat of the bunsen burner or other flame. Revolve the tube so that the heat is spread over as much of the surface as possible, and then watch for the reaction. You can see from this that reagents cause reactions that result in the throwing of some element out of solution, and that element is always the chemical sought for.

Now, to identify the chemical, you have only to refer to the result of the experiment as set forth in the minute instructions for each chemical, and if the precipitation is as it should be according to the instructions, or if the

proper color has been produced according to the instructions, the experiment has been successful and you have found the chemical you are looking for.

Now, if you have reason to believe that the chemical you are looking for may be present, yet your first experiment has failed to disclose its presence, then I would suggest that you make the experiment over again, omitting the water with the fluid and test the fluid straight and without water. This will naturally give you a stronger reaction and one which can more readily be seen.

After you have tried the test twice, using the recommendations set forth here, and fail to get a reaction, then you can rest assured that the chemical you are looking for does not appear as a part of the fluid.

Now, as soon as you have completed your test for any one of these elements, and have disclosed that this or that chemical is or is not present, then you can go on to the next in the list, and so forth, until the entire list of chemicals prohibited by your state law have been tested for.

If you will take the trouble to clean the test tube after using it, you can keep it until the next lot of fluid comes along and can test the next lot with the same test tubes and so on until by accident the tube is broken.

Chemical Tests.—1. *Test for Mercury, Arsenic or Zinc.* For determining whether a given fluid contains mercury, zinc or arsenic, or all of these.

Get a small quantity of ten per cent. solution of sodium bicarbonate from your druggist. This solution is your reagent for determing whether all of these poisons are

present, or whether any of them are represented in the formula of the fluid.

Operation—

(a) Place a few drops of your embalming fluid in the test tube then add an equal amount of ordinary water. Then add a few drops of the reagent (the 10 per cent. solution of sodium bicarbonate).

(b) Heat the lower end of the test tube over the flame as provided in the general instructions.

(c) A deposit of whitish substance in the bottom of the test tube indicates that all of these chemicals or any one of them is present.

(d) If you fail to notice this precipitation and fail to see a deposit of a whitish substance in the bottom of the test tube, try the test over again, using fresh fluid and leaving out the water this time. If, after doing this, you find no deposit of a whitish substance, you will know that arsenic, mercury and zinc are not present.

2. *A. Test for Arsenic alone.*—Get a small quantity of 10 per cent. solution of copper sulphate and a like quantity of ammonia from your druggist. These solutions are your reagents for determining whether arsenic alone is present.

Operation—

(a) Place a few drops of your fluid in the test tube; then add a few drops of water; then add a few drops of the solution of copper sulphate; then a few drops of ammonia, and heat the lower end of the test tube over the flame, as provided in the general instructions.

(b) A deposit or precipitation of an olive green sub-

stance in the bottom of the test tube indicates that arsenic is present.

(c) If you fail to find this olive green precipitation the first time, test it over again, using fresh fluid, and leave the water out this time. If, after doing this, you find no olive green precipitation, you will know that arsenic is not present.

B. *Test for Arsenic alone.*—(Either this test or the preceding one can be used).

Get a small quantity of 10 per cent. solution of silver nitrate, also some ammonia, from your druggist. These solutions are your reagents for determining whether arsenic is present or not.

Operation—

(a) Place a few drops of your fluid in the test tube; then add a few drops of water; then add a few drops of ammonia; then add a few drops of the silver nitrate test solution.

(b) Heat the lower end of the test tube over the flame as provided in the general instructions.

(c) A deposit or precipitation of an orange colored substance indicates that arsenic is present.

(d) If you fail to find this orange colored substance the first time, test it over again, using fresh fluid and leave the water out this time. If, after doing this, you find no orange colored precipitation, you will know that arsenic is not present.

3. *Test for the Salts of Zinc.*—(This test will operate for both chloride of zinc and sulphate of zinc).

In making the test for arsenic, using the 10 per cent.

solution of silver nitrate and the ammonia as reagents to give you the orange colored precipitation, and, having discovered by obtaining this orange color that arsenic was present, you have the orange colored substance left in the test tube. In other words, take the result of the silver nitrate and ammonia test and use it to find whether zinc is present or not.

Operation—

(a) Take this orange colored precipitation and the liquid it is contained in, and add additional ammonia until the liquid becomes clear again. Use the heat to assist in the re-dissolving.

(b) When the solution has become clear, add a few drops of 10 per cent. solution of alum (which you can get from your druggist).

(c) Apply the heat as directed in the general instructions, and if there is any zinc in the solution a white precipitate or deposit will appear in the test tube.

(d) If the white precipitate does not appear, test it over again, using the result of the arsenic test again, as provided in section (a) of this operation, and if the white precipitate does not appear at this time you know that zinc has not been used as a part of the fluid.

4. *Test for Mercury alone.*—Get a small quantity of 10 per cent. solution of potassium iodide from your druggist. This will act as your reagent to determine whether mercury is present or not.

Operation—

(a) Take a few drops of your fluid and add a few

drops of water and add a few drops of the potassium iodide solution.

(b) Heat the lower end of the test tube over the flame as provided in the general instructions.

(c) A yellow or red or yellow turning to red precipitate or deposit will indicate that mercury is present.

(d) If this test fails to show the yellow or red or the yellow turning to orange precipitate, test it over again, using fresh fluid and fresh potassium iodide solution, leaving the water out this time. If you fail to get the colors as above stated this time, you will know that there is no mercury in the solution.

5. *Test for Chloral Hydrate.*—Get a small quantity of 10 per cent. solution of caustic soda from your druggist. This will act as a reagent for the detection of chloral hydrate in your fluid.

Operation—

(a) Take a few drops of your fluid and place it in the test tube with a few drops of the caustic soda test solution.

(b) Apply heat to the bottom of the test tube as provided in the general directions.

(c) The formation of the odor of chloroform indicates the presence of chloral hydrate.

(d) If you do not get the odor of chloroform, test it over again using fresh fluid and fresh caustic soda solution leaving the water out this time If you fail to get the odor of chloroform this time, you will know that there is no chloral hydrate in the solution.

6. *Test for Carbolic acid.* (Phenol).—Get a small

quantity of a ten per cent. solution of ferric chloride from your druggist. This will be your reagent for showing the presence of the carbolic acid.

Operation—

(a) Take a few drops of your embalming fluid and place in the test tube along with a few drops of the ferric chloride test solution.

(b) Apply heat to the test tube as provided in the general instructions.

(c) The presence of carbolic acid will be indicated by a black or blue color or precipitation.

(d) To further prove the presence of carbolic acid you will then add a couple of crystals of oxalic acid to the solution and in the presence of carbolic acid the black or blue color will turn to a dirty yellow color.

(e) If this test does not result in the discovery of the carbolic acid, test it again, using fresh fluid and fresh ferric chloride solution and leave out the water. If this additional test fails to disclose the presence of the carbolic acid, you will then know that it is not present.

7. *Test for Creosote* (a mixture of guaiacol, cresol and other phenols obtained during the distillation of wood tar).—In making the test for carbolic acid you will have obtained some of the ferric chloride test solution from your druggist. This will act as your re-agent for the detection of creosote in the fluid.

Operation—

(a) Place a few drops of your fluid and a few drops of water in the test tube and add to this a drop of the ferric chloride test solution.

(b) Apply heat to the lower end of the test tube as provided in the general instructions.

(c) The presence of creosote will be indicated by the formation of a greenish-brown color, ending with a brownish precipitation.

(d) If this test fails to show the presence of the creosote, make the test over again, using fresh fluid and fresh ferric chloride test solution and leaving the water out. If this test fails to result in the brownish precipitation, you will know that creosote has not been used in the fluid.

8. A. *Test for Formaldehyde.*—In making the test for chloral hydrate you will have secured from your druggist a quantity of 10 per cent. solution of caustic soda. Now, as an addition to this, it will be necessary to get a small quantity of a 10 per cent. solution of resorcin test solution.

Operation—

(a) Place a few drops of the fluid along with a few drops of water and a few drops of caustic soda and a few drops of the resorcin solution in a test tube.

(b) Apply heat as directed in the general instructions.

(c) The presence of formaldehyde will be indicated by a reddish color of the solution.

(d) If this test fails to show the presence of formaldehyde, test it over again, using fresh liquid and caustic soda and resorcin solution and leaving water out. If this test fails to get the reddish color for you, you will know that there is no formaldehyde in the fluid.

B. Another test for formaldehyde.

In making this test you will use the silver nitrate so-

lution and the ammonia solution which you had provided for other tests previous to this one.

Operation—

(a) Place a few drops of ammonia and silver nitrate solution in the test tube.

(b) Apply heat as directed in the general instructions.

(c) Add a few drops of your fluid and in the presence of formaldehyde you will see a mirror form on the inside of the bottom of the test tube.

(d) If this test fails to result in a mirror on the bottom of your test tube, you will then take fresh ammonia and fresh silver nitrate solution and fresh fluid, operating as described in sections a-b-c, of this operation. If the mirror then fails to form, you will know that there is no formaldehyde in your fluid.

CHAPTER XXIV.

ROOM DISINFECTION.

Room Disinfection.—There is as yet no single procedure by which every article in an ordinary furnished room, which has become infected, can be simultaneously and certainly disinfected. For rendering rooms that have been occupied by persons suffering from contagious diseases, free from danger, the most trustworthy plan consists in a combination of the best features of several methods that have been from time to time proposed.

Realizing that disinfection should be carried out from the very beginning of a man's illness with a contagious or highly infectious disease, it is thought best to devote a few paragraphs to the sick room and its disinfection, as taken from the Idaho laws relating to the duties of the boards of health.

The Sick Room and Its Disinfection.—"The room should be located by preference in the upper part of the house, and as much isolated from the other parts of the house as possible, and it should contain as much sunlight and fresh air as possible; drafts to be avoided. It should contain nothing except what is absolutely necessary for the comfort of the patient and the convenience of the attendants. Carpets and hangings and all bric-a-brac and unnecessary articles should be avoided or removed, and the room should be provided with a small gas stove, and

a wash boiler of about four gallons capacity, or with a steam sterilizer, and all small infected articles, such as napkins, towels, handkerchiefs, etc., should be immersed in boiling water or soda solution (see page 138), or steam, when they become soiled or before being laundered. The patient should be provided with his own eating utensils, which should be boiled in soda solution after he has used them. All refuse of his meals should be burned or thrown into a covered receptacle containing milk of lime (see page 182), or a one per cent. chloride of lime solution (see page 183), which should be renewed each day. All furniture, the floors, door knobs, and all surfaces, such as sills, mantel pieces, etc., should be at least once in two days wiped with cloths moistened in a three per cent. solution of carbolic acid or a one per cent. solution of chloride of lime, or one part of formalin to twenty parts of water. A separate clinical thermometer, tongue depressor, or what other instruments may be necessary, should be provided, and when not in use these articles should be kept in a one to three per cent. solution of carbolic acid or a one per cent. solution of chloride of lime. After having been cleansed in such solution they should be, before using, rinsed off with warm water. Great care should be taken of all bed linen, and portions of the body of the patient that may be soiled by evacuations, secretions or excretions. Portions of the body that may become soiled should be cleansed by a three per cent. carbolic acid solution, or by a one per cent. chloride of lime solution, and all bed linen or garments of the patient's that may become soiled should be removed with as little agitation as possible, and immersed in the following solution:

Carbolic acid .... 3 parts.
Common soft soap .... 2 parts.
Cold water ....100 parts.

This solution should be contained in a covered vessel that should be brought to the side of the bed when used. By immersing soiled clothing in this solution not only all non-spore bearing bacteria are destroyed, but in the cold state this solution dissolves all blood and fecal stains which would be rendered indelible if the soiled articles were exposed at once to steam or boiling water. They should be permitted to soak in this solution for about two hours, when they may be rinsed out with clean water and subjected to the ordinary process of laundry.

The attendant should be protected by a cotton slip or coat that reaches from the neck to the floor, and this should always be worn when on duty. At the end of the day this garment should be immersed in either of the solutions named, after which it may be boiled or steamed and laundered. The attendant should also be provided with carpet overshoes, which should be disinfected often, preferably by steam, or by exposure to formaldehyde gas, as has been described. (See page 151). All other infected clothing should be packed in tightly closing canvas bags, and conveyed to the regular disinfecting station, if one exists, to be disinfected by steam. Where such stations are not accessible, one may disinfect with the vapors of formaldehyde (see page 155). Whenever the attendant leaves the room or ward both the slip and the overshoes should be left in the room at a point close to the door of exit where they can be easily reached when she or he re-

turns. The attendant should bathe frequently. The hands, face, beard, and hair should be frequently rinsed in a one to five thousand solution bichloride of mercury, or a one per cent. solution of carbolic acid, or a one per cent.

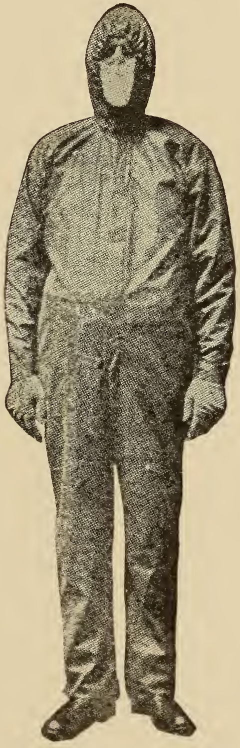

Fig. 13.—A disinfecting suit.

solution of chloride of lime. The most desirable solution for sponging the entire body both of the patient and the attendant is one consisting of one part of Labarraque's solution to five or seven parts of water.

Room Fumigation.—The effectiveness of a fumigation depends upon the following:

(1) Tightness of the room.
(2) Length of closure.
(3) Quality of the agent.
(4) Temperature.
(5) Distribution of the articles.
(6) Moisture.
(7) The rapidity of the generation.

(1) *The tightness of the room* is one of the essential points in the complete fumigation of a room that is so often neglected. No matter how strong, efficient and trustworthy the gas employed may be, if the room is not absolutely tight, the gas will escape, and produce only an antiseptic effect.

After closing the doors and windows, (excepting the place of exit), seal all the cracks and crevices with gummed paper, or calk them with towels, waste, or the like. Be careful to close the hot air register and to properly close all ventilators, fireplaces, and other openings.

This may be done while the body is being prepared or after it has been prepared, and the body may remain in the room during the disinfection.

When everything is in readiness, touch off the disinfectant, make your exit and seal the door on the outside.

(2) *The length of closure* depends upon the agent one is using, but it will be safe, no matter what agent is used, to keep the room closed from 8 to 12 hours, when the room is to be opened, aired and well ventilated.

(3) *The quality of the agent* will depend upon the following:

(a) Controllability.
(b) Cheapness.
(c) Penetrability.

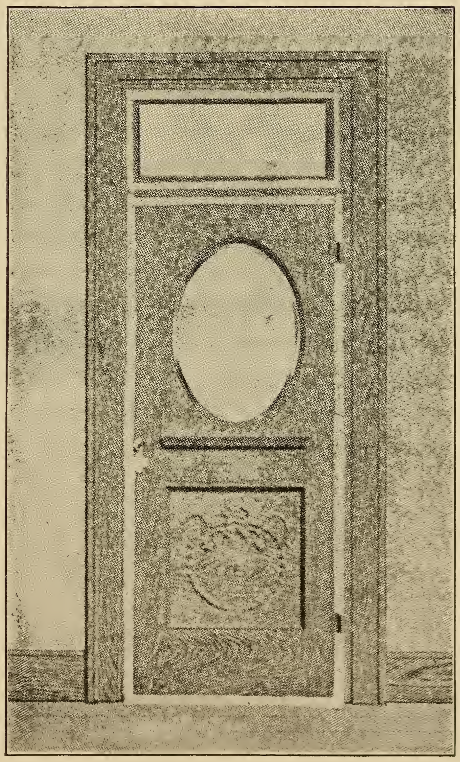

Fig. 14.—Method showing how to seal doors with paper strips (Rosenau).

(d) Effectiveness.
(e) Effect on fabrics.
(a) By *controllability* is meant the using of the agent

which when used for fumigation purposes in a closed room will do just what we want it to do. Some of the agents which are recommended, require the use of fire for their generation, which is always dangerous, others are more or less of an inflammable and explosive nature and should one not knowing the nature of the agent in this regard, light a match or have in their mouth a lighted cigar, great damage would occur, even to the loss of life. For this reason when sulphur is the agent to be used, it should be placed in a tub or other vessel that has rather high sides, and the bottom of the vessel should contain at least one inch of water. The generator used in the key hole method is not always controllable, for in the generation of the gas, paraform may be formed which will clog up the nozzle, causing enough back pressure on the generator to cause it to explode. Hydrocyanic acid gas is very inflammable and explosive and for this reason is not easily controlled.

(b) By *cheapness* is meant that we should buy the cheapest disinfectant we can which will have all the qualities necessary to make it a good disinfecting agent. There are many costly disinfecting agents, but we do not get enough remuneration to warrant their use, and after all, it would not be necessary to use the costlier agents for there are cheaper ones on the market which when considering all the points under the quality of the agent are even better.

(c) By *penetrability* is meant that the agent used must have the power of passing into the material to be disinfected to such a depth that even the most hidden germs will be killed by its action. Some agents are very good

surface disinfectants, but they lack the power of penetration which would render them valueless for the more complete disinfections.

(d) By *effectiveness* is meant that the agent we are using should do the work which we want it to do. If there are germs to be destroyed, or if there be insects to be killed, we must know that the agent we are using will be effective to that extent. Formaldehyde gas is one of the most efficient germicides, yet it should not be used as an insecticide, for it will not be effective as such. Sulphur dioxide is only a poor insecticide, and for that agent to be of value it must be used in connection with water and then the active principles become the sulphurous acid gas.

Then again our agent may be one that is very effective, but because we have neglected some of the other points, such as the tightness of the room, the length of closure, the temperature, the distribution of the articles, or the moisture, it will be rendered ineffective.

(e) Lastly, the *effect on fabrics* is a very important point. If we have a delicate carpet, lace curtains and draperies with delicate shades of colors, we do not want these colors destroyed.

If we have assured the owner of the property that there would be no damage in this regard and then should the damage occur because of our lack of knowledge of what the agent would do, the loss would be the disinfector's and he would probably have to stand it. For this reason the disinfector should know the bleaching properties of any agent he may use, especially that of sulphur and chlorine.

So, then, in summing up the quality of the agent, we find that formaldehyde is one of the best, if not the best, all round disinfectant that can be obtained, when considering the above five points.

(4) The *temperature* of the room should always be considered when one is about to disinfect a room. Thorough disinfection can not be obtained at a temperature less than seventy-five degrees. If the room does not happen to be of this temperature it would be advisable to place a coal oil stove, a gasoline stove with an oven, or some other means, so as to raise the temperature up to the requirement.

Temperature is an important factor in disinfecting with formaldehyde. The gas condenses at 20 degrees C. to the solid form, paraform. Disinfection with this gas should never be attempted if the temperature is under 10 degrees C. In cold weather the room to be disinfected should be heated by artificial means, otherwise some other disinfecting agent must be selected. The action of the gas seems to be about the same between the temperatures of 10 degrees C. and 27 degrees C., but higher degrees of heat materially aid the disinfecting power of the gas.

(5) In the *distribution of the articles* all materials to be disinfected in the room, such as clothing, etc., should be opened out and hung loosely upon lines stretched in the room for the purpose, or over the backs of chairs. Books handled by the patient, or suspected of being infected, should be burned, and in fact, all materials of little or no intrinsic value should be treated in the same way. All furniture should be moved at least a half foot away from the wall, and all pictures taken down from the walls and

set up on edge on the floor so that the gas may have free access to all sides. All bureau drawers should be opened out and the contents carefully spread out loosely. If there is an adjoining closet to the room, it should not be overlooked, but rather should be entered and all the contents brought out into the main room so that the material will have more free exposure to the gas. And last of all, although seldom done, the carpet should be loosened from the floor and several old chairs placed underneath, so that the gas will have a free circulation. However, with all the preparation, it must be remembered that all the infected materials and those suspected of being infected, should be handled as carefully and as lightly as possible, or else the too vigorous shaking up of the dust or infectious matter may be the means of spreading the disease.

(6) *Moisture* should always be present in some form, as it is due to moisture that the penetration is increased. The disinfector must then make a study of the disinfecting agents to determine whether the moisture is present in the free state in combination with the evolved gas, or if the moisture will have to be added separately into the room to get the desired result.

Although formaldehyde gas cannot be produced in the dry state, yet a certain added amount of moisture is essential to obtain successful results. It is estimated that the atmosphere should contain 75 per cent. of saturation of moisture to obtain the maximum effect. It is therefore advisable in dry weather to place a basin of boiling water in the room just before evolving the gas, although most of the apparatus in the market, supplies means of producing watery vapor.

(7) *The rapidity of generation.*—There are many methods of evolving gases. Some of the methods are slow, and some are fast. For the ideal disinfection the gas must be thrown off with great rapidity, and in great quantities. This will bring a great volume of gas into the room to be disinfected, very quickly, and in such great volume that every nook and crevice will receive the gas and thus be disinfected. For effectiveness, then, remember that there must be a rapid generation of the gas.

General Suggestions.—The practice of setting dishes or receptacles about in a room in which carbolic acid, chloride of lime, or other disinfectants are placed, has no effect to disinfect, and this method should be abandoned.

It should be remembered that pure air and sunlight are most valuable and effective disinfectants, and that nearly all known disease germs are quickly destroyed, when subjected to the strong rays of the sun, hence these agents should be utilized whenever possible, but the sun's rays can not be depended upon to the exclusion of all other methods.

A slow generation of gas for room fumigation is not very efficient, and the best results will be obtained by using a gas that can be evolved quickly and in great quantities.

If more than one room in a house is to be disinfected, each room should be done at a time, and care taken that infected articles are not carried into the disinfected rooms.

Gases as a rule can not be depended upon to exert their disinfecting influence very deeply, therefore any article which there is reason to believe is deeply or badly in-

fected should be removed for other treatment, depending upon its character.

The strength of all gases and the time of exposure necessary to insure disinfection have been determined by exact laboratory experiments, but the conditions found in actual practice are so variable that we must allow for a liberal excess to make up for inevitable wastage.

The steps to be taken after a room has been disinfected, which will aid materially in the thoroughness of the disinfection are briefly as follows:

The room should be entered and all bed clothing, pillows, mattresses, and other clothing in closets, chests, trunks, etc., should be put in canvas bags brought for the purpose by the operators and sent at once to the disinfecting station, where they are to be subjected to the action of steam. If there is no disinfectant station in the community, see disinfection for clothes under special disinfection (page 252). The action of steam completes the disinfection of those articles that were only superficially acted upon by the gaseous vapors.

In the meantime, the ceiling and walls are to be wiped down with cloths wrung out in a 3 per cent. carbolic solution, a 1 : 2000 corrosive sublimate solution, or a 5 per cent. chloride of lime solution. All furniture and all horizontal surfaces, such as window sills, cornices, etc., are to be similarly wiped off, after which the floors are to be scrubbed with hot soda solution of about 4 per cent. strength.

In the case of hangings, valuable curtains, tapestries, carpets, etc., that might be injured by steam, it is best to remove them after the general fumigation and have them

thoroughly beaten or shaken on some distant lot, after which they should be freely exposed to the direct sunlight.

When the room has been disinfected and cleaned by the processes outlined above, it should be thoroughly aired for a few days before it is again to be occupied.

Charges.—In the larger cities, disinfection is in the hands of the health boards and the expense is often borne by the city. There is no fixed charge for such work, but where formaldehyde disinfection is done, the usual price for a house is from $1.50 to $2.00 per 1000 cubic feet. It depends upon the manner in which the work is done. For a single room of the average size, $3.00 is a reasonable price, and for two rooms $5.00. In smallpox disinfection, it is advisable to have an assistant who is immune, (one who has had smallpox) do the inside work. In many cases it is required that all paper be removed, especially in a room where the patient has been sick. This is done by wetting down the paper with the regular corrosive solution, and then scraping it off when soaked through. From a business standpoint it is suggested that in doing disinfecting work in smallpox cases, the least said about it the better.

CHAPTER XXV.

ARTICLES REQUIRING SPECIAL ATTENTION.

Air.—It is quite impossible to disinfect the air of a room during its occupancy by a patient. Any of the known volatile substances in sufficient concentration to kill the microorganisms would make life unbearable. It is therefore absurd to place such substances as carbolic acid, chlorinated lime, or formalin in an open pan in the sick room or the water closet, with the idea that they are serving a useful purpose in disinfecting the atmosphere or in preventing the spread of infection.

The infection of few, if any, of the communicable diseases is given off in the exhaled breath. The exhaled breath is always sterile, no matter how many microbes may be contained in the inhaled air. That is, the process of respiration acts as a bacterial filter for the atmosphere. When the air becomes infected it is usually in an indirect way. From smallpox and the exanthemata the infection is given off into the air from the patient mainly in fine particles of epidermis that float about the compartment with the dust. From tuberculosis and diphtheria the infection may float into the air from the dried sputum.

The atmosphere surrounding the patient may also become contaminated with the germs of tuberculosis, diphtheria, the pneumonic form of plague, and other diseases in which the infection is discharged from the body in the

expectoration, by coughing, sneezing, speaking, etc. In these explosive expiratory movements, a fine spray is thrown several feet from the mouth, and may be carried with the currents of the air to all portions of the room.

The infection of some diseases is carried in the air, in the bodies of mosquitoes, or on the bodies of flies, instead, as was formerly supposed, as a miasm or poison directly vitiating the atmosphere. Malaria, which means bad air, is the type of these so-called "miasmatic diseases." From this we may infer that fly-screens and mosquito netting are more important in many sick rooms than germicidal agents, as far as the dissemination of such infections through the air is concerned.

In the cases where the infection is liable to contaminate the surrounding air, a thorough ventilation of the sick room should be maintained. The infection disposed of in this way is generally lost by dilution, or killed by the sun. There is nothing equal to the open fire place for the ventilation and purification of the air of the sick room, for by this method the infection is not only carried away, but is destroyed by the heat of the fire in exit.

Proper precautions must be taken at the bedside to prevent the infection leaving the body in a live and virulent form. These precautions differ for each class of infection and will be described under each disease discussed.

The hanging of sheets wet with bichloride of mercury or some disinfecting solution at the doorway serves a useful purpose in arresting some of the infection that may be floating in the air, and thus limiting its dispersion. It must, however, be remembered that sheets, while serving a useful purpose, are not an absolute guarantee, for they

dry out very quickly and it is difficult to make the sheet close the openings so that there will be no air currents around the edges, especially if the doorway is used for persons passing in and out.

When a room has been badly infected and the air of the room is suspected, it should always be given a preliminary fumigation with one of the gases, which will diminish the probability of the infection spreading through the air, and will protect the operators who have to take up the carpets or prepare the bedding and the other contents of the room for steaming or other processes.

Bandages, Gauze, etc.—These may be sterilized by boiling, steaming or dry heat, in any of the apparatus described under these processes. Any of these articles that have become soiled by usage should be burned.

Bed Linen, Body Linen, etc.—Articles of this character should always be disinfected after contact with any of the communicable diseases, for they are very apt to be infected. This may readily be done by boiling or steaming, or by immersion in one of the ordinary germicidal solutions. Care must be taken in boiling or steaming woolen underwear because of their liability to shrink. Special care is necessary in washing and disinfecting towels, sheets, underwear and the like that are soiled with discharges, such as pus, blood, or excreta. If such articles are heated or boiled without special precautions being first taken, they will become indelibly stained by the coagulation of the albuminous matter which becomes fixed in the fiber. A method to prepare articles of this kind containing stains should be to soak them in a 5 per cent.

solution of carbolic acid for two hours, and then remove and wash in the ordinary way.

Beds.—Wooden and iron beds may be effectively disinfected by a mechanical cleansing with a hot disinfecting solution, such as bichloride of mercury, using a 1:1000 solution, or carbolic acid solution, using a 5 per cent. solution. Care should be taken so as not to overlook any of the cracks or crevices, especially in wooden beds, which should be taken apart.

Bedding.—Mattresses and pillows are among the most difficult objects to disinfect, on account of the deep penetration required. It is often important that they should be thoroughly disinfected throughout their mass on account of the very intimate contact with the patient and the likelihood of their being deeply soiled with the infected discharges. Therefore nothing but steam should be trusted to render these objects safe.

Books.—With the exception of their external surfaces, books cannot be disinfected in the bookcases or on the shelves of houses and libraries. However, if the books have not been handled or exposed to infection in any way except by their presence in the sick room, there is no reason to consider any part of the book except the exposed surface infected. Such books may be rendered safe by exposing them to formaldehyde gas without first disturbing the books in any way.

Books which have been handled by the patient, or which have been otherwise exposed to infection require particular care in their disinfection, on account of the diffi-

culty of penetrating with any germicidal substance between the leaves.

Books may be satisfactorily disinfected in a specially constructed box by means of formaldehyde. They must be arranged to stand as wide open as possible or be hung on wires. Under these conditions the exposure should be continued twelve hours in the special chamber or box, with high percentages of formaldehyde and temperature of 80 degrees C., a partial vacuum having first been produced.

When only a few books are to be treated in the absence of a special apparatus they may be disinfected by dropping two or three drops of a forty per cent. formalin solution on every second page, taking care to distribute the drops well. The book is then laid in a tight box or drawer in which more formalin is sprinkled, and left in a warm place not less than twenty-four hours.

Pamphlets and unbound volumes may be steamed without serious harm. Steam is not applicable to the disinfection of bound books on account of the glue and the leather.

Brushes.—Good brushes can be boiled or steamed without injury, and this is the best method to disinfect them. If boiled in a solution containing soap, soda, borax, or one of the alkalies, the brush may be more readily cleansed of the collection of oleaginous matter and epithelial debris that collect about the bristles. Brushes made of poor bristles or glued backs are injured by boiling. Such brushes must be mechanically cleansed in a soap or alkaline solution, and then soaked for an hour in corrosive sublimate 1:1000, or carbolic acid 3 to 5 per cent. solution, or a 3 to 5 per cent. formalin solution. A brush may

be cleansed and disinfected at the same time by mechanical washing in a 1 per cent. solution of lysol or tricresol. The ordinary exposure to formaldehyde gas connot be trusted to render the brush safe. Brushes used by the embalmer should always be disinfected after using them on a corpse.

Cadavers.—(See care of the body after death, page 269).

Carriages, Ambulances, Cars, etc.—These may be disinfected by having built a small tight structure in which they are enclosed and then surrounded with formaldehyde gas. By using percentages of formaldehyde gas, such conveyances may be given satisfactory surface disinfection in an hour. This method would be particularly applicable where time is an important factor.

When the vehicle has been used for the transportation of a communicable disease, the cushions, lap robes, curtains, floor carpet, upholstery, and similar objects must be removed for steaming, immersion in one of the germicidal fluids, or for treatment according to the method given for its particular class, especially if the interior of the vehicle has been soiled with the discharges or other infectious matter.

Clothing.—Clothing may be disinfected by a great variety of methods. It may be boiled, steamed, soaked in disinfecting solutions, or exposed to dry heat or the action of gases. Of all the methods steam is the most reliable, but it has the disadvantage of shrinking some woolen goods, or creasing them or setting them out of shape. Good clothing and fine fabrics may be steamed

without appreciable injury if they are exposed to steam under pressure, so managed that condensation and undue wetting are avoided, and provided that the articles are hung or loosely laid in the steam chamber so that they do not come in contact with any metal parts, and finally, provided that, as soon as the steaming is completed, the articles are immediately removed and stretched and hung or shaken in the air until they are cooled or dried.

The combination of high percentages of formaldehyde gas with dry heat in a partial vacuum is a splendid method for the disinfection of clothing fabrics, and baggage on a large scale. The method is rapid, has sufficient power to penetrate heavy fabrics, and is not injurious.

Clothing may be disinfected with formaldehyde gas in a room or inclosure by any of the methods given for the evolution of the gas. Proper care must be taken to so arrange the clothing that the gas may have free access to all the surfaces, and the exposure should not be less than twenty-four hours to insure penetration.

Boiling and immersion, while very efficient, are limited to the disinfection of the simpler and cheaper articles of clothing.

Colors.—Care must be taken not to injure colors in the process of disinfection. Many of the cheap prints run when wet, and such should not be disinfected by boiling, immersion in the disinfecting solutions, or by steaming. In steam disinfection objects are sometimes soiled by being in contact with other objects, dyed with soluble colors, and this possibility must always be guarded against in loading the chamber.

Sulphurous acid gas is very ruinous in this respect. It

bleaches practically all the vegetable and aniline dyes. It is very apt to discolor white lead paint, (oxide of lead), by the formation of black lead sulphide. It does not attack white zinc paint when dry.

Formaldehyde gas has practically no effect on colors. It can be used to disinfect an oil painting, water color, or pastel. It does not effect the coloring matter of fabrics, excepting occasionally the delicate lavenders.

Chlorine is a very active bleaching agent, and acts injuriously on all the pigments commonly used in the arts. Chlorinated lime, and Labarraque's solution likewise effect colors, on account of the chlorine liberated by their decomposition.

Oxygen, ozone, and hydrogen peroxide are also very powerful bleaching agents.

Solutions of mercury salts, of carbolic acid and the cresols, or formalin, have little special action upon pigments commonly used in the arts.

Carpets.—Carpets and rugs are very apt to become infected with almost any of the infectious diseases, and they are troublesome to handle properly. In cases where they have become soiled with the infective discharges, or where gross carelessness has prevailed in the sick-room, they should be subjected to a preliminary exposure to one of the gaseous disinfectants, and then carefully taken up, wrapped in a sheet wet with bichloride of mercury, and removed for steaming. Stains due to organic matter, such as blood, sputum, and excreta, must be removed before the steaming, else they will become fixed. After the steaming they may be given a mechanical cleansing and hung up in the sunlight for several days.

Carpets that have been exposed in the sick room where proper precautions have not been taken at the bedside to prevent the spreading of contagion, may be safely treated without taking them up. The carpet may be disinfected in place by wetting it with a 5 per cent. solution of formalin, and keeping the room closed not less than twenty-four hours, or by exposing the carpet to the action of formaldehyde gas in full strength for twenty-four hours.

Carpets that have become infected by the spilling of discharges, etc., should have the contaminated area immediately saturated in a strong solution of formalin. Carpets in rooms that are being given a general disinfection with formaldehyde gas may be sprinkled with formalin just before the room is closed and the gas evolved.

Cotton.—Cotton fabrics may be boiled, steamed, and subjected to dry heat at 150 degrees C. for an hour, exposed to formaldehyde gas or immersed in any of the ordinary disinfecting solutions, without appreciable injury.

Sulphurous acid gas not only bleaches the cotton but rots the fiber, owing to the action of the sulphurous acid which is formed by the gas in the presence of moisture and oxygen, and is therefore inapplicable.

Combs.—Combs may readily be rendered safe by soaking in formalin, carbolic acid or corrosive sublimate, after which they may be mechanically cleansed. The rubber and celluloid of which combs are made will not, as a rule, stand boiling, steaming or dry heat.

Draperies, Hangings, Curtains.—As a rule these furnishings of the room do not come in contact with the

patient or the discharges, and therefore may be disinfected by formaldehyde gas while the room itself is being treated.

In case these articles are contaminated so that they need more than a surface disinfection, they should be steamed, in accordance with the plan laid down for the handling of carpets, or immersed in one of the germicidal solutions.

The sick room should not contain draperies, hangings, or other unnecessary articles, of this character, and it is always advisable to remove them, as well as the carpets before the possibility of contamination.

Excreta.—Lime in one of its forms is best suited for the disinfection of excreta in any quantity. For small amounts, formalin, carbolic acid, or one of its derivatives, as tricresol, lysol, saprol, is efficient.

In hospitals the infective discharges are sometimes boiled in an appropriate vessel, with the addition of a deodorizing substance, as potassium permanganate.

Whatever chemical substance is used, some of it should be placed in the vessel to receive the dejecta, and more of it is added afterwards and the mass thoroughly mixed. Let the mixture stand a sufficient length of time, depending upon the strength and nature of the disinfectant. In estimating the amount of disinfectant required for the disinfection of excreta in camps, quarantine stations, etc., count upon an average of 400 grams of solid excrement per person per day, and 1500 to 2000 c.c. of urine.

Excreta must always be so protected that it will not become a breeding place for flies and other insects, which are prolific ways of spreading cholera, typhoid fever, and perhaps other diseases.

Milk of lime is very cheap and an efficient disinfectant for excreta. As officially prescribed for this purpose in the U. S. Army, it is prepared by the addition of 1 part by weight of the freshly slaked lime to 8 parts of water.

Chlorinated lime is a powerful deodorant, vigorously attacking the effluvia of putrefaction, and is a useful disinfecting agent for excreta. A solution of good chlorinated lime in water in the strength of 1 per cent., by weight, has been shown to disinfect typhoid stools and cholera stools in ten minutes, while a 1 per cent. solution will destroy anthrax bacillus in two hours. Thoroughly mixing the chlorinated lime with the fecal matter to be disinfected is essential.

In the U. S. Army a 4 per cent. strength of chlorinated lime in solution is officially prescribed for use in the disinfection of the excreta of the sick.

Formaldehyde ranks high among the list of germicidal chemicals useful for the disinfection of the dejecta. It penetrates deeply and is not hindered in its action by the albuminous matter present. Enough should be added so as to make 5 per cent. of the mass. The vessel must be tightly closed at least one hour. As a deodorizer it acts almost immediately.

Carbolic acid in 5 per cent. solution added to a similar bulk of excreta cannot be depended upon to render the latter sterile in one hour. It can, however, be used for the disinfection of infected stools, such as cholera, typhoid, etc., taking care to mix well and let stand at least one hour.

Tricresol, lysol, and saprol are valuable agents for the

disinfection of fecal matter in small amounts, on account of their energetic action, and because their efficiency is not impaired by the presence of albuminous matter. Sufficient quantities of these phenol derivatives must be added so as to be present in 2 per cent. of the entire mass and thoroughly incorporated. Carbolic acid and its derivatives are more expensive than lime and without any special advantages.

Ferrous sulphate is very extensively used for the disinfection of excreta, but its germicidal powers are too weak to recommend it for this purpose. It is claimed also to have deodorant properties, but this is doubted by some. In the French army ferrous sulphate is used in 10 per cent. solutions, and it is officially laid down that at least 250 c.c. of such solution should be used per day for each person using the latrine.

Dry earth promotes the disiccation of the excreta, thus preventing putrefactive changes while absorbing the odors. It has no inherent germicidal or antiseptic properties, but is a useful means of disposing of dejecta in camps and country places when lime and chemicals are not at hand. A better method under these circumstances is to burn the dejecta.

The corrosive sublimate is totally unfitted for the disinfection of excreta, because it coagulates the albumen with which it combines, and therefore lacks penetration. It does not destroy bad odors.

Special care of the feces, urine and the sputum should be taken in cases of cholera, dysentery, intestinal tuberculosis, diphtheria, scarlet fever, etc.

Privy vaults should not be tolerated in thickly popu-

lated communities, and under all circumstances they should be made as near water-tight as possible and so arranged that their contents can be frequently removed after having been mixed with ashes, dry earth or lime. The contents of the privy vault should never be permitted to percolate through the soil and thus contaminate the surrounding wells and cellars. Probably the most practical and cheapest disinfectant for the contents of the privy vault is the milk of lime. A good rule is to add to the vault or the cesspool about two quarts of milk of lime daily for each individual using the vault. If this amount is used, not only is the odor prevented, but the mass is continuously disinfected. Whenever cesspools or vaults are used, all infected matter such as typhoid, cholera and dysentery stools should be thoroughly disinfected before being deposited in such vaults.

Food.—The ordinary methods of cooking are, as a rule sufficient to render meats and vegetables safe from the danger of carrying infection. The food must be well cooked throughout, and afterwards must be guarded against contamination by dust, by flies and other insects, by handling with infected hands, or by contact with infected dishes.

The remnants of food or drink that have formed part of the patient's meal should be burned, particularly if the case is one of diphtheria, tuberculosis, cholera, pneumonia, or any of the exanthematous diseases in which the food is apt to become infected by handling or by contact with the secretions of the mouth. This also applies to food left in the room at the time of death.

In districts where cholera and typhoid fever or epi-

demic dysentery prevail, raw foods, such as salads, celery, tomatoes and fruits, may be disinfected by one-half hour immersion in a 3% solution of tartaric acid and afterwards washed in boiling water.

There is plenty of evidence now to prove that parasitic and infectious diseases may be spread through the consumption of uncooked foods and vegetables, even when pestilent diseases do not prevail in the epidemic form.

Roots, bulbs, fruits and other articles of food may be given an efficient surface disinfection by immersing them in a 5% solution of formalin. This treatment does not harm the food value of these articles and is not poisonous.

Floors.—The floors should always be given special attention because they are likely to be infected. The sputum of tuberculosis cases, of pneumonia, diphtheria, etc., too frequently finds lodgment on the floor. The plague bacillus has been found in the dust and dirt of the floor.

The floor may best be disinfected by soaking, or by a mechanical cleansing with any one of the strong disinfecting solutions such as bichloride of mercury 1 : 1000, carbolic acid 5 per cent., tricresol 1 per cent., etc.

Bichloride of mercury should not be used for the disinfection of the dirt floors frequently found in the poorer hovels of our country. Carbolic acid, or one of its derivatives, is more trustworthy for this purpose, as its action is not hindered by the presence of albuminous matter.

Furniture.—Ordinary furniture, such as chairs, tables, desks, bureaus, cabinets, etc., made of wood, with hard polished surfaces, may be effectively disinfected with for-

maldehyde gas or sulphurous acid gas, according to any of the methods given for the evolution of the gases. All the drawers and doors should be opened, so as to expose all portions to the action of the gas.

Furniture may also be disinfected by a mechanical cleansing with any of the disinfecting solutions, taking care not to overlook any surface and to get the solution into all cracks and crevices.

Upholstered furniture is one of the bugbears of the disinfector, on account of its bulk, its value, and the deeper penetration sometimes required. If the upholstery is leather or other impervious material, it may be treated with one of the germicidal liquids, care being taken to get well into all the puckered tucks of the cushions. If the article is covered with a tapestry or other pervious fabric, the only efficient way of rendering it safe is by soaking the cushions through and through with a 5% solution of formalin and leaving the furniture in an inclosed space for twenty-four hours. Fortunately this treatment does no special injury to fine fabrics.

Upholstered furniture that has simply stood in the house or room in which a case of infectious disease has occurred, and which has in no way come in contact with the patient or the infected materials, may be considered as being infected merely upon the surface, and therefore may with perfect safety be treated by gaseous disinfection. It is always well, in using formaldehyde, which is practically the only gas applicable for these objects, to sprinkle or wipe the surfaces of the upholstery with a 5% solution of formalin just before closing the room preparatory to liberating the gas.

Glassware.—Glassware, porcelain, china dishes, and the like, may be disinfected by boiling, steaming or immersion in any one of the disinfecting solutions.

Hands.—The hands should be thoroughly washed off and disinfected after contact with infected material of any kind. It is very difficult to disinfect the skin, especially around the finger nails, so that a cursory immersion in a bichloride solution will not suffice. After contact with the skin of a smallpox case or one of the exanthematous diseases, or after contamination with the discharges of cholera or typhoid, the hands should be immersed in a hot bichloride of mercury solution 1 : 1,000, then given a very thorough cleansing with soap and water, using a nail brush. After this the hands should again be immersed in a 1:1,000 solution of bichloride of mercury for three minutes.

An antiseptic liquid soap is desirable for use in this way, and we would recommend the following formulas, which are extremely simple and can be made with little trouble: Rx.

Soft soap,	1 pound.
Hot water,	7 pints.
Carbolic acid,	3 ounces.

Or,

Rx.

Soft soap,	1 pound.
Hot water,	7 pints.
Lysol,	2 ounces.

Directions for making. Dissolve the soft soap in the hot water and add either the carbolic acid or the lysol.

Instruments.—The instruments used by the embalmer may be disinfected by many methods, but they are best sterilized by a careful cleansing and boiling in a 1 : 500 solution of sodium hydroxide, which can be made by dissolving 28 grains of C. P. sodium hydroxide in 1 quart of water.

They should be held in the boiling solution for 15 minutes or longer. Any stains of long standing can be removed by rubbing in connection with the use of this solution. This does not rust the steel and does not dull the cutting edge.

Leather, Hides, Skins, Fur, etc.—Leather, hides, skins, and fur, are ruined by boiling or steaming. They may be treated by immersion in one of the germicidal solutions. Leather which had not received a surface dressing is rendered hard and brittle by wetting and should therefore be disinfected by one of the gases.

Formalin fixes leather by combining with its albuminous constituents, rendering it brittle, and should therefore not be used for this substance.

Linen.—Flax and linen fabrics may be boiled, steamed or disinfected by immersion in any of the ordinary chemical solutions used for this purpose. It may also be subjected to formaldehyde gas without appreciable harm. Sulphurous acid gas rots linen fiber, as it does cotton, and bleaches dyes, and should therefore be avoided.

Money.—Money may convey the infection of the communicable diseases, especially smallpox and the exanthemata.

Metallic money may best be treated by immersion in

a solution of carbolic acid 3 per cent., of formalin 3 to 5 per cent. Boiling water, steam, or dry heat is also applicable to the disinfection of specie.

Paper money may be disinfected by sprinkling the notes with formalin, taking care to sprinkle the solution in small drops and upon the face of each bill, then placing in a tight box in a warm place for six hours.

The United States Government has recently installed machinery to actually wash and cleanse paper money. It is said that the bills are renovated and come out looking like new money.

Pictures and Paintings.—Formaldehyde gas does not injuriously affect photographs, lithographs, prints in black and white or colors, or pastels, and is practically the only method applicable for the disinfection of these articles.

Rags.—Rags may be disinfected by any of the methods applicable to fabrics; but as they are especially apt to be contaminated with the discharges and other infectious materials, they therefore require treatment with methods which penetrate deeply—or, better still, methods which sterilize, such as steam, boiling, or immersion in one of the strong germicidal solutions.

When they are absolutely valueless the best method is to burn them.

Rubber.—Rubber is injured by dry heat. Pure rubber may be boiled or subjected to steam under pressure without injury.

Articles made of impure rubber, such as rubber blankets, rubber tubing, and other rubber articles used by the embalmer, are ruined by boiling or steaming, and must

be disinfected by immersion in one of the germicidal solutions.

Silks.—Silks seldom need disinfection, and fortunately so, for it is difficult to treat without injury to the texture or color. Formaldehyde gas does not injure the fiber and has no effect upon the great majority of colors; but the delicate lavenders of aniline origin are sometimes slightly modified in tint after exposure to this gas.

While steam does injure the silk fiber appreciably, it ruins the fabric, so that this method of disinfection is totally inapplicable.

Sputum.—The sputum, not alone of the sick, but of the well also, and likewise the purge from a dead body, is often ladened with the infection of disease, especially pneumonia, pulmonary tuberculosis, diphtheria, plague, and other affections of the air passages.

Infection is spread by means of the sputum, especially when it dries and is disseminated by the air currents. Another fruitful method of spreading diseases, the infection of which is found in the sputum, is by the act of kissing; also by using spoons, forks, cups, etc., which have been in the mouth of the sick or those whose sputum is infected and shortly afterward used without being disinfected. There is still another way in which sputum contaminates the air and the surfaces of objects, viz., in coughing, sneezing, speaking, and other acts of an explosive expiratory character the sputum is sprayed into the air of the room, often to a considerable distance, even a couple of yards from the mouth, and the air currents will carry the minute droplets to all parts of a room.

The sputum should be kept well covered until it is disposed of. Simply keeping water in the bedside cups or in the cuspidors will prevent the danger of the dissemination of infection through the agency of dried sputum, though an antiseptic solution is to be preferred for this purpose.

The best way to disinfect sputum is by heat; a small quantity placed on the fire will burn up. The same method is also applicable for handkerchiefs and other objects that have been used to hold sputum.

Next to burning, boiling or steaming is the safest method of treating infected sputum. The boiling may be accomplished in any appropriate vessel, and the steaming may be done in either streaming steam or in the autoclave under pressure. In hospitals and in private houses this method is recommended, care being taken not to heat the ordinary glass or glazed earthenware cuspidors too suddenly for fear of breaking them.

The disinfection of sputum is difficult to accomplish with the chemical solutions, on account of its dense consistency and tenacious character, which hinder penetration. Bichloride of mercury solutions are entirely inapplicable to the disinfection of this material. The bichloride of mercury coagulates the albuminous matter of the sputum and thereby prevents penetration, and by uniting with the albuminous substances it is used up and rendered inert so far as its disinfecting powers are concerned.

Carbolic acid in 5% solution may be used for the disinfection of sputum, but it can not be considered trustworthy, because it coagulates the albuminoid matter, though not so energetically as bichloride of mercury.

Tricresol or lysol in 2% solutions are well suited for this purpose.

Formalin in three to five per cent. solutions may also be used, using generous amounts and well incorporated, and remaining in contact with the infected sputum no less than one hour.

Table Ware.—Great care must be exercised in disinfecting knives, forks, spoons and dishes used by patients suffering from communicable diseases. Cholera, typhoid, tuberculosis, pneumonia, diphtheria, plague, and the exanthemata may be conveyed by inattention to this precaution. Table ware is most readily disinfected by scalding.

Urine.—The urine is usually disinfected with the excreta. It should always be disinfected in the case of cholera, typhoid, and most of the communicable diseases, by adding sufficient carbolic acid to make a 5% solution, of bichloride of mercury to make a 1:1,000 solution, or formalin sufficient to to be present in the proportion of 3 to 5 per cent.

Walls.—The walls and ceiling of a room are as a rule infected only superficially, and may be effectively disinfected by one of the gaseous processes. Such surfaces may also be disinfected by washing down with bichloride or carbolic solutions, preferably hot and applied by means of a hose or any other method that will thoroughly wet the surface. The solution is always to remain until it dries, and is followed by a mechanical cleansing. When applicable it is better to scrub or mop the wall with the hot disinfectant solution by means of brushes, cloths, etc.

The spraying of walls and other surfaces with a very fine spray of corrosive sublimate solution, or any material that is not volatile at the ordinary temperature, is a very faulty method, for the entire surface is not wetted and portions thus escape disinfection. In applying the solution with a hose it is always advisable to begin with one corner of the ceiling, and systematically wet every portion of the ceiling, walls and floor, from above downward. This method is particularly applicable to the holds and compartments of vessels, to freight cars, outhouses, cellars, waterclosets, wooden buildings and other rough structures.

Disinfection of One's Own Person.—Lay aside all unnecessary clothing. In the absence of a disinfecting suit, wear duck trousers tied around the ankles, and a duck coat buttoned to the chin. Tie sleeves at the wrist. A skull cap, made by taking a handkerchief and tieing knots in the four corners, and a pair of rubber shoes, will complete the outfit.

In handling diphtheria and scarlet fever, wrap the body in a sheet saturated with a solution of 1:1,000 corrosive sublimate. Remove body to an adjoining room if possible during the disinfection of the room, first having thoroughly disinfected and embalmed the body.

After finishing the work, your suit may be taken off and disinfected by placing it in a tight satchel into which some 40 per cent. formaldehyde has been poured. Wash your entire body with a 1 : 3,000 bichloride of mercury solution, being careful not to touch the eyes or the mucous surfaces.

Then wash in clean water, after which soap may be used. Do not neglect a thorough washing of the hair and finger nails. An alcohol wash, in addition to the above, is beneficial. Put on clean clothing. The shoes should be sponged off with bichloride. Where an old suit has been worn for this work it should be burned.

Rubber gloves are always reliable in handling contagious diseases.

When carbolic acid is used for disinfecting the hands, face or other parts of the body, use 2 per cent. solution or 2½ ounces to a gallon of water.

The Care of the Body After Death.—In the most dangerous communicable diseases the subject should be thoroughly washed with a 2% solution of carbolic acid, or a 4% solution of chloride of lime, or a 1:1,000 solution of bichloride of mercury. After these solutions have been allowed to dry on the subject, they should then be washed with soap and water. After this a thorough arterial and cavity embalming should follow. In all cases the rectum and orifices of the body should be tightly plugged with cotton soaked in corrosive sublimate or carbolic acid solutions.

Then it is advisable that the body be at once enveloped in a sheet saturated with either a 5% carbolic solution or a 4% chloride of lime solution, or a 1:1000 solution of bichloride of mercury, and placed in the casket in which it is to be buried. (See the State Board rules). These cadavers should be buried as soon as decency permits. The law should, and usually does, forbid a public funeral in these cases.

With the less dangerous of the infectious diseases,

such stringent measures are not observed. The body may be washed in any of the strong disinfectant solutions mentioned. The rectum should be plugged in all cases, especially in those of intestinal infection, and the mouth and nose also, especially in pulmonary and throat infections. A thorough arterial and cavity embalming should follow.

Even in the milder infectious cases it is not advisable to expose the remains in open caskets.

All bodies should be buried or cremated, the results of the two processes of final disposal differing, as a rule, only in the time required for their accomplishment.

The burial of bodies of persons dying from infectious diseases does not, as has been sometimes surmised, tend to perpetuate pathogenic germs. Rather elaborate experiments by Losener and others have shown that the longevity of non-spore-bearing bacteria under the ordinary conditions of earth burial is not great, a few weeks sufficing for the complete disappearance of the cholera spirillum and the bacillus of diphtheria, etc.

"The hygienic arguments against earth burial, therefore, do not seem to be decisive, whatever be the force of the aesthetic and economic objections."—Jordan.

When a body is buried, the place selected should be so located as not to endanger the neighboring drinking-water supplies.

The Transportation of Dead Bodies.—When the transportation of dead bodies became so general that rules and regulations for the government of this branch of railroad and express traffic became necessary, every state made rules to govern the traffic within its own boundary lines.

This gave rise to a condition of misunderstanding and worriment on the part of shipping and receiving funeral directors, which was caused by the conflicting rules in each state that the body might pass through. The preparation of the body in a manner prescribed in one state was not considered sufficient in another, and so the conditions relative to the transportation were highly unsatisfactory.

In some states the rules were formulated by legislative enactment, and in some the control of the laws was placed in the hands of the health authorities. The transportation companies, realizing the importance of uniform laws to regulate this matter, communicated with the National Funeral Directors' Association. The result was that the National Funeral Directors' Association appointed a committee of conference with a like committee of health authorities and general baggage agents, at Cleveland, O., in June, 1897. At this meeting a set of rules and regulations were prepared, and committees appointed to submit them to the National Conference of Boards of Health, which met at Nashville, Tenn., in August of the same year. On account of there being no National Board of Health, this was the only body to which they could be submitted, and the recommendation and adoption of them would make it general throughout the United States. Eminent lawyers were engaged to look up the power of the Boards of Health in the different States, and their opinions were that these bodies could regulate the transportation of the dead, and that their rules and regulations would have the same effect and power of law.

At this meeting the rules were generally discussed, and with some slight amendments were adopted and are

now in general force throughout the United States and Canada. Prior to this, embalming was not looked upon as being an important factor in the transportation of dead bodies. Air-tight sealing was required where the distance traveled took more than eighteen hours by rail, regardless of the time the body had been dead. The transportation of bodies dead of diphtheria, scarlet fever, etc., was not allowed. At the meeting above mentioned the health boards made certain regulations which would permit these bodies to be transported provided the persons preparing such bodies were fully competent. Almost all of the State Boards of Health have adopted these rules, and all railroad companies are receiving such bodies for shipment.

Because of a difference in the meaning and verbiage of transportation rules in many instances, it will be necessary to refer you to the rules of your own state which appear on the back of the shipping papers used in your state.

THE END.

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